COMPARATIVE ECONOMICS OF PIGEONPEA PRODUCTION UNDER TRANSPLANTED AND CONVENTIONAL METHODS IN SELECTED DISTRICTS OF NORTHERN KARNATAKA

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CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDIX

1. INTRODUCTION

Agriculture is one of the most important activities in developing countries which provide food and nutrition security to human beings and raw materials to various agro- based industries. It continues to be the main stay of Indian economy and an effective antidote to poverty and unemployment. Recognizing its importance in the economic development of the country, sustained efforts have been made for improving agriculture during the successive five year plans. A number of policy decisions have been taken to give a high priority to agriculture and of late, the production of pulses have been identified as the thrust area considering the dietary, economic and other associated factors.

Indian rural economy is basically considered to be a crop economy. In India, agriculture and other allied activities contribute significantly to the Gross Domestic Product (GDP), accounting nearly 16 per cent of the total GDP. It provides employment to around 64 per cent of the work force while contributing 18 per cent of the total exports. India with only 2.3 per cent of world's total land area supports 18 per cent of human and 15 per cent of live stock population in the world. (Source: google.co.in)

Pulses occupy an important place in Indian agricultural economy as they are rich sources of proteins and constitute 10 to 15 per cent of India's food grain diet. Major portion of Indian population belongs to vegetarian group and every person on an average is required to consume 70 to 80 gm of pulses per day in order to maintain good health and physique, according to the recommendations of ICMR.

India is the largest producer and consumer of pulses in the world accounting for 33 per cent of the world area and 27 per cent of the world production of pulses. In India, pulses were grown on 23 million hectares area with a production of 15 million tones, with a per hectare yield of 600 kg (agropedia.iitk.ac.in, 2010). Besides their high nutritional value, pulse crops have a unique characteristic of maintaining and restoring soil fertility through nitrogen fixation. Their cultivation improves the physical characteristics of the soil through their deep and well spread root system. The pulse crops add more nitrogen to the soil than the nitrogen provided by the chemical fertilizers.

1.1 Origin and history

Red gram or pigeonpea (*Cajanus cajan* (L) mill.*sp*.) is one of the major pulse crop of tropics and sub-tropics and owed with several unique characters. It ranks second important pulse crop next to bengalgram. It finds important place in farming systems adopted by small holding peasants in large number of developing countries. Red gram is considered to be origin of peninsular India. It is a perennial shrub and a short annual crop in India and as a perennial in many other countries, where pods are harvested at regular interval. The crop has deep root system and hence highly drought tolerant. More than 350 vernacular names of red gram have been recorded. However, it is commonly called as Tur, Arhar, Toovar, Toor, Togari, Gango pea and No eye pea. It is mostly consumed as split dhal, but also consumed as vegetable in many countries. Pigeon pea is of dietary importance with seed protein content of about 21 per cent, which is highest in the case of legumes.

1.2 World scenario

Globally, it is widely grown in Asia, Africa and America, mostly as an intercrop with cereals based farming system. Red gram is grown throughout the world especially in South Asia, Eastern and Southern Africa, Latin America, Caribbean countries and Australia. According to FAO statistics, worldwide red gram was grown in about 4.64 million hectares and its production was 3.43 million tonnes having productivity of 780 kg/ha in 2007. India is the largest producer of red gram accounting 90 per cent of total production and 80 per cent of total area of the world. Other major red gram producing countries are Kenya (4.36 Per cent) Myanmar (11.77 per cent), Malawi (2.68 per cent) and Uganda (1.83 per cent). The productivity is the highest in Uganda (1000 kg/ha) followed by Myanmar (925 kg/ha), Nepal (896 kg/ha) and India (685 kg/ha) (FAO STAT, 2007).

1.3 Indian scenario

India is the largest producer, consumer and importer of pigeonpea in the world. India occupies 80 percent of world pigeonpea area and accounts for 90 per cent of world output of tur. In India pigeonpea is mainly grown in Maharashtra, Madhya Pradesh, Rajasthan, Uttar Pradesh, Andhra Pradesh and Karnataka. Madhya Pradesh is the leading producer. According to fourth advanced estimates of 2010-11 released by Department of Agriculture and Co-operation, red gram occupies an area of 4.09 million hectares and production of about 3.27 million tonnes, having an average yield of 799 kg per ha.

In Karnataka pigeonpea is largely grown in northern parts, especially in Gulbarga and Bidar districts. The state occupies an area of about 5.96 lakh hectares with a production of 3.15 lakh tonnes, having an average productivity of 556 kg per ha. Gulbarga is known as "pigeonpea bowl of Karnataka". Gulbarga has an area of about 3.79 lakh hectares with production of 1.94 lakh tonnes and a productivity of 539 kg per hectare. Bidar with an area of 62,667 hectares, production of 50,127 tonnes with a productivity of 842 kg/hectares stands second, while Bijapur having an area of 48,686 hectares and production of 19,472 tonnes with average productivity of 421 kg per hectare holds third position.

However, with all these advantages yet the cultivation of pulse crops has been concentrated in the marginal dry lands. As a result from the pulse production activities the desired yield levels are not being obtained in India, this situation has created a mis match between demand and supply and situation has forced to import pulses from Australia and other countries at a huge cost. In order to address the short supply- production bottleneck, there is a need to motivate the farmers to cultivate the pulses in well endowed situation in order to step-up the country's pulse production. These pulse crops also combined as mixed or relay crop along with other main components of the cropping system, which ensures in providing supplementary income to the growers and also in sustaining levels of pulse production as accomplished by market demand.

1.4 Transplanted method of pigeonpea cultivation

Transplanting method of pigeonpea cultivation is one of the recent developments in pigeonpea cultivation and gaining importance in pigeonpea growing farming community. It improves both production and productivity. It is recommended for successful and profitable cultivation of red gram. In this method pigeonpea seedlings were raised in nursery, seedlings will be ready in about 30-40 days and then transplanted into the main field. It yields about 12-14 qtls/acre in rain fed conditions and about 16-18 qtls/acre in irrigated conditions. Now it is cultivated mainly in Gulbarga and Bidar districts and in the days to come it may occupy larger area in the state especially in northern parts of Karnataka. During 2009-10, about 4000 hectares of area was under transplanted pigeonpea (KVK.Bidar). Hence the present study is proposed to evaluate the comparative production economics of transplanted and conventional methods in the changed scenario with the following specific objectives.

1.5 Objectives of the study

1. To work out cost and returns in transplanted and conventional method of pigeonpea cultivation.
2. To analyse the resource use efficiency under the two methods.
3. To study the factors influencing in adoption of transplanted method of pigeonpea cultivation.
4. To document problems faced by growers of pigeonpea.

The following hypotheses were set for the study

1. Transplanted method of pigeonpea yields higher income than conventional.
2. Resource use efficiency was higher in transplanted method of pigeonpea cultivation.
3. Age, education, income level, area under pigeonpea, irrigation availability, extension contact and family labour availability are the factors influencing in adoption of transplanted method of pigeonpea.

1.6 Presentation of the study

The study has been presented under following chapters

Introduction: In the introductory chapter nature and importance of the research problem, specific objectives and hypotheses of the study have been presented.

Review of literature: It deals with review of the relevant past studies related to the present study.

Methodology: This chapter gives an over view of the study area, the nature and sources from where relevant data have been collected and the analytical tools employed for evaluating objectives of the study

Results: The results of the study and their analysis have been presented in this chapter in the form of tables.

Discussion: It emphasis on interpretation of the results and attempts to establish relationships between certain variables and their outcomes

Summary and Policy Implications: Brief summary of the main findings of the study along with policy implications drawn from the findings have been presented.

References: The list of referred books and journals are presented in this section

2. REVIEW OF LITERATURE

A review of the past research helps in identifying the conceptual methodological issues relevant to the study. This would enable the researcher to collect information and subject to sound reasoning and meaningful interpretation. A brief review of the earlier work related to the present study is presented in this chapter. Keeping in view of the objectives of the study, the reviews are presented under the following headings.

2.1 Costs and returns in cultivation of crops

2.2 Resource use efficiency in cultivation of different crops

2.3 Factors influencing in adoption of modern technology in cultivation

2.4 Problems faced by growers in production

2.1 Costs and returns in cultivation of crops

Gadre and Mahale (1988) worked out per hectare returns from cotton and its non-commercial competing crops in vidharbha region of Maharashtra and reported that the cost of cultivation (Cost C) per hectare was Rs. 3848.00 for hybrid cotton, followed by mung-sunflower (Rs. 1984) and tur as sole crop (1845). The same for desi improved cotton, mung-gram and mung-wheat were 1541, Rs. 1495 and Rs. 1404, respectively. While measuring the profitability of different cropping systems on the basis of net returns per hectare the authors reported that that tur (sole crop) gave highest returns (Rs. 2905/ha), followed by mung-safflower (Rs. 2627/ha) and mung-wheat (Rs. 1805/ha). Net returns for hybrid cotton, desi improved cotton and mung-wheat sequence worked out to Rs. 1062, Rs. 888 and Rs. 948, respectively. The authors inferred that, on the basis of net returns per hectare, all the substitute crops were more profitable than hybrid cotton (except mung-wheat sequence) as well as desi improved cotton. They also concluded that for cotton crop, there were economically good substitute crops like tur, mung-safflower and mung-gram available for vidharbha region.

Arjun Prasad and Sam (1990) conducted cropping systems studies during 1978-81 at Central Soil and Water Conservation Research and Training Institute, Bellary. Among the different cropping systems tried, both triple cropping sequences of bajra-cowpea-jowar and bajra-coriander-jowar gave higher combined net returns of Rs. 18, 850 and Rs. 17,981 per hectare and cost of cultivation were Rs. 5406 and Rs. 5447 per hectare, respectively. The net returns in these systems were 55 and 47 per cent more than that of maize-safflower cropping system.

Singh and Grover (1992), in their study on wheat based crop sequences in different agro-climatic areas of Punjab, observed that variable costs of wheat-paddy sequence were higher (Rs. 2027.35/ha) than wheat-cotton (Rs. 2002.13/ha), wheat-maize (Rs. 1887.35/ha) and wheat-potato (Rs. 1503/ha) sequences. However, returns over variable costs were higher in wheat-maize sequence (Rs. 2023.56/ha), followed by wheat-paddy (Rs. 1823/ha), wheat cotton (Rs. 1248.65/ha) and wheat-potato (Rs. 857.35/ha) sequences.

Prasad (1993), while studying the economics of groundnut production in different zones of Karnataka, found that the cost of production was highest in the North-Eastern dry zone (Rs. 3248.30 per ha) followed by northern dry zone (Rs. 3165 per ha) and central dry zone (Rs. 2848.28 per hectare). The total cost was lowest in the southern dry zone (Rs. 1107.07 per ha). He attributed higher seed cost which accounted for a large proportion of the total cost. It varied from 36.53 per cent in northern dry zone to 44.76 per cent in North-Eastern dry zone of the total cost.

Pawar (1995) studied IPM technology in rice and observed that, (i) Number of pesticides sprayings reduced in IPM area as compared to Non-IPM area. (ii) Total cost of production including herbicides, pesticides, fertilizers *etc.* remained low in IPM area as compared to that of non-IPM area. (iii) Yield of paddy was more in IPM as compared to Non-IPM area. (iv) The cost benefit ratio varied from 1:1.1 to 1:3.9 in IPM fields and 1:3.4 in Non-IPM fields.

Olekar (1996) studied the comparative profitability of sunflower based cropping sequences under rainfed conditions in Bijapur district, of Karnataka. In the case of small farmers, the net profit was high in groundnut-sunflower cropping sequence (Rs. 15356/ha) and least in sunflower-fallow sequence (Rs. 6685/ha). In the case of large farmers also the net returns were highest in groundnut-sunflower system. The benefit cost ratio was highest in the case of sunflower-chickpea sequence (2:51:1).

Anonymous (2002) a comparison of cost and returns per hectare of mung, gram, maize, wheat, mustard and cotton on sampled farms revealed that pulse crops were less favorable in terms of net returns wheat followed by cotton gave maximum net returns per hectare. Among pulses mung yielded significantly higher returns than that of gram

Benagi *et al.* (2004) reported that in large scale demonstration of IPM of redgram on an area of 125 acres in Gulbarga district, the seed yield in IPM fields was 7.69 qtl /ha and in non-IPM field wad 7.30 qtl/ha and the percent pod damage in IPM field was 10.8 compared to 17.1 in non- IPM fields. Further they estimated by adopting the IPM module an additional income of Rs 1457 per hectare

Moorthy *et al.* (2004) reported that the adoption of Integrated Pest Management (IPM) module using marigold as trap crop and three sprays of *Helicoverpa armigera* nuclear polyhedrosis virus (HaNPV) in tomato crop. The results showed that IPM significantly reduced the insecticide sprays, cost incurred towards insecticide and fungicide sprays, fruit borer (*Helicoverpa armigera*) incidence and cost of cultivation. The IPM also increased gross and net returns compared to non-IPM plots. The cost incurred by non-IPM farmers was significantly higher than IPM farmers. Cost of insecticides used by IPM farmers was on average Rs. 1253/ha, while that of non-IPM farmers was Rs. 1337/ha. The cost of cultivation incurred by IPM farmers was lower (Rs. 24,923/ha) than that incurred by non-IPM farmers (Rs. 34,283/ha). The highest yield obtained by IPM farmers was 87.4 tonnes/ha, and that of non- IPM farmers was 31.3 tonnes/ha.

Rajeshwari (2004) in an attempt to study the cost and returns of coconut based farming systems in Tumkur district of Karnataka found that the farmers following Farming System-I *viz.,* Coconut + Arecanut + Ragi + Dairy Enterprise were getting the highest net farm income of Rs. 85,600 per farm and the cost of cultivation was found to be Rs. 1,59,645.The major components of cost of production were amortized establishment cost, operational cost, rental value of land and material cost.

Radha and Chowdry (2005) studied the cost of seed production as well as commercial production of cotton and compared the costs and returns of seed production and commercial production of cotton in Karnool district of Andhra Pradesh. The cost of cultivation was very high in seed production of cotton (Rs. 74,412/acre) compared to commercial production of cotton (Rs. 26,461/acre). Human labour, manures and fertilizers cost, plant protection chemical cost and rent for leased in land formed major components of total cost in seed production of cotton whereas human labour, plant protection chemicals cost, manures and fertilizers cost and rent for leased in land formed major components of total cost in commercial production of cotton.

Sukhpal Singh *et al.* (2005) observed the adopters of IPM and IRM technology in cotton could get significantly higher yield as compared to that by non-adopters. These technologies have been found cost-effective due to higher production and reduce the per quintal production cost by Rs 253 and Rs 175, respectively. These technologies have been found to generate more income and employment as the adopters could earn Rs 6840/ha and Rs 5901/ha more income as compared to that by the non-adopters in cotton production.

Biradar (2007) in his study of economics of redgram based cropping systems in Bidar district found that medium farmers incurred highest total cost in cropping system (Redgram + black gram, redgram + Soyabean, redgram + green gram) and large farmer in cropping system (Redgram + Jowar, redgram sole). Net return obtained by small farmers were highest in cropping system (Redgram + Jowar, redgram sole) highest net return obtained by large farmers in cropping system (Redgram + black gram, Redgram + Soyabean, Redgram + green gram).

From the above review it was observed that, the cost of production was high for large farmers followed by medium and small farmers due to higher level of use of fertilizer and quality seeds, but net returns was high for small farmers followed by medium and large farmers due to lower cost and high gross return and efficient utilization of family labour. Under irrigated condition, net return from sugarcane was high and under rain fed condition net return from redgram was found to be high.

Biradar (2007) studied the cost and returns structure of major redgram based cropping systems in the Bidar district. The study revealed that under rainfed condition, total variable cost was high in CS-V (Rs. 11,114/ha), followed by CS-III (Rs. 11,056/ha) and CS-II (10,960/ha). The total fixed cost was high in CS-II (Rs. 9875./ha), followed by CSIII (Rs. 9, 729.63/ha) and CS-IV (Rs. 7,643/ha). The maximum net returns were found under CS-II (Rs. 18, 932/ha), followed by CS-I (Rs. 1,333/ha), CS-III (Rs. 16,285/ha), CS-IV (Rs. 12,961/ha) and CS-V (Rs. 5,470/ha). Returns per rupee of investment was found to be highest in CS-II (1.91), followed by CS-I, CS-III, CS-IV and CS-V with values of 1.82, 1.78, 1.71 and 1.29, respectively.

2.2 Resource use efficiency in cultivation of different crops

Bisaliah (1977) decomposed the yield difference between the two wheat production technologies in Punjab into its constituent sources. He found that improved production technology contributed 15 per cent of the total change in output (40.50 per cent). The increased use of inputs under Mexican wheat contributed about 25.50 per cent to the total difference in output. Among the different inputs the contribution of fertilizer, capital and labour were 15, 8 and 2 per cent, respectively.

Bal *et al.* (1983) employed the Cobb-Douglas model to study the resource use efficiency, factor share and productivity of various factors in crop cultivation in the central districts of Punjab at two points of time, namely 1972-73 and 1980-81. It was noted that elasticities of production (in value terms) of human labour, draught labour and rental value of land have declined in 1980-81 over 1972-73, but that of irrigation had increased. The average level of use of other factors had increased over the period. It advocated substitution of human labour with other factors, mainly with irrigation, fertilizer and weedicides

Muralidharan (1987) studied the resource use efficiency in rice production in Kerala, employing the Cobb-Douglas production function. The adjusted R^2 was 0.84 indicating that 84 per cent of the variation in yield of paddy was explained by the estimated production function. The coefficient of land and human labour were positive and significant at one per cent probability level.

Deshmukh *et al.* (1991) used Cobb-Douglas production function to study resource use efficiency under different farming systems. Production elasticities of gross cropped area and expenditure on manures and fertilizers were relatively higher on irrigated farms as compared to rain fed farms under the bajra-based farming system.

Vishweshwar (1994) employed Cobb-Douglas type of production function to measure the efficiency of inputs used in the production of cotton by IPM and non-IPM adopted farmers in malaprabha command area in Karnataka. The study indicated that the ratio of MVP to MFC for land was greater than one, while it was less than one for labour. It was negative for seeds, fertilizers and pesticides in conventional farmers. In case of IPM adopted farmers, the MVP to MFC ratio for land, labour, seeds and fertilizers were greater than one and it was negative for fertilizers.

Viswanath (1997) analyzed resource productivity in paddy cultivation and indicated that seed and human labour contributed significantly to the total output in most of the zones in Karnataka during kharif season. Fertilizer contributed significantly in southern transition zone and hilly zone. In summer, seed contributed significantly to the output only in central dry zone. In most of the zones, human labour was a major contributor to the output. Fertilizer did not contribute significantly to the output but its coefficients were positive in all the zones.

Gaddi *et al.* (2002) using output decomposition model, estimated contribution of different sources to yield gap in cotton. The variables included in the model explained more than 87 per cent of the variation in cotton production in demonstration field. Human labour, bullock labour and seeds turned out to be the most important variables governing production.

Capital input did not exert any significant influence in cotton production, while the plant nutrients were excessively used. The production elasticities of all inputs on all the farmers' fields were invariably lower than unity implying diminishing marginal productivity with respect to each of these inputs.

Verma (2002) employed Cobb-Douglas production function for evaluating resource use efficiency in onion. The marginal value product of seed, manures and fertilizers, human labour and machine power were (Rs. 0.15, Rs. 1.51, Rs. 0.69 and Rs. 0.28 respectively) found to be positive on small farms, while it had negative value on bullock labour, plant protection and irrigation (Rs. –0.13, Rs. –0.49 and Rs. –0.47 respectively). This implies that the small farms were under utilizing seed, manures and fertilizers, human labour and machine power and bullock labour, plant protection and irrigation were used excessively on the farms. In the case of large farms, marginal value product of seed, manures and fertilizers, human labour, bullock labour and plant protection were (Rs. 0.80, Rs. 0.34, Rs. 0.18, Rs. 0.01 and Rs. 0.15) respectively found to be positive while it had negative value of machine power and irrigation (Rs. –0.16 and Rs-0.01) respectively implying that large farms were under utilizing seed,manures and fertilizers, human labour, bullock labour and plant protection while machine power and irrigation were over utilized by the large farms. Thus indicating there is scope for increasing their use up to the optimum level where the efficiency of the input use is maximum.

Sunanda and Narender (2003), while studying resource productivity of mesta farms in Srikakulam district of Andhra Pradesh, observed that mesta fiber accounts for 70 per cent of raw jute. The cultivation involves intensive human labour in addition to manures and fertilizers, seed and cattle labour. The Cobb-Douglas production function analysis for these variables indicated constant returns to scale on all farm size groups. The marginal value product to opportunity cost ratios for all farm size groups indicated resource use efficiency and revealed the scope of adjustments and reorganisation of resources, so as to obtain higher returns in mesta cultivation.

Wadear (2003), while analyzing the resource use efficiency and productivity at various factors involved in different animal based farming systems in the three dry zones of Northern Karnataka, concluded that, the milk production increased with the farm size and ranged from 4.5 to 5.0 litres per day per animal. In milk production, green fodder, concentrates and labour were significantly contributing factors in all the three zones.

Saikumar (2005) studied the resource use efficiency in different farming systems of three districts of north-eastern Karnataka employing the Cobb-Douglas production function. The adjusted R^2 was 0.76, 0.58 and 0.54 for Bidar, Bellary and Raichur districts, respectively indicating that 76,58 and 54 per cent of variation in yield could be explained by estimated production function. The co-efficient of cost of seeds and cost of feeds + concentrates in Bidar, fertilizer + FYM cost in Bellary and fertilizer +FYM cost and labour cost in Raichur district were positive and significant at 5 per cent probability level.

2.3 Factors influencing in adoption of modern technology in cultivation

Ramamoorthy (1983) evaluated the economic impact of Integrated Pest Management on cotton in Tamil Nadu and reported that the cotton growers of project village have earned a net profit of Rs. 4081 per hectare as against Rs. 5083 by farmers of non-project village. The additional profit of Rs. 1002 per hectare earned by non-project village may be due to introduction of synthetic pyrethroids which were most effective pesticides on cotton pests.

Anantharaman and Ramanathan (1986) found a remarkable change in the knowledge level and adoption behavior of farmers and the satisfactory spread of technology to other farmers confirm the significant impact of the lab to land programme not only on its beneficiaries also on the cassava farming community of the adopted villages.

Chitins and Bhikkggaonkar (1987) investigated the major constraints that caused technological gaps in the process of adoption of dry faming technology. Four types of constraints namely 1) technology, 2) credit and economic service, 3) supply and 4) information transfer were identified during the study. They firmly advocated for adequate supply of inputs, timely advice and training through demonstrations.

Chandargi *et al.* (1991) conducted a study in Dharwad taluka of Karnataka state and reported that more than 80 per cent of the jowar farmers had adopted the practices *viz.,* variety, seed rate and time of sowing, whereas, the practices like spacing, compost mannuring and chemical fertilizers were adopted in full by less than 80 per cent of farmers, pest and disease control was not adopted by any farmer.

Juliana *et al.* (1991) conducted a study on adoption of integrated pest management practices on cotton crop in Vasudevanannur block of Tirnalvelli district (TN) and reported that nearly half (47.5%) of small farmers and more than half (52.5%) of big farmers were found to be medium adopters of IPM practices. Higher percentages (42.5%) of big farmers were found to be higher adopters when compared to small and marginal farmers by 22.5 and 5.00 per cent respectively.

Koppad (1991) conducted a study on adoption pattern of groundnut cultivation practices among beneficiaries and non-beneficiaries of National Oilseed Development Projects (NODP) in Dharwad district of Karnataka state and observed that cent per cent of the beneficiaries and non-beneficiaries of NODP had followed recommended sowing time, gypsum application and time of harvest. A large majority (87 and 65%) of the respondents in both the groups had adopted the use of improved variety and plant protection measures respectively, followed by seed rate (85 and 67%), rhizobium culture (75 and 64%), spacing (71 and 69%) and seed treatment (59 and 57%).

Muthuraman (1995) noticed that nearly fourty per cent of the farmers interviewed were medium adopters and about thirty per cent of farmers belonged to each of the other two, low and high adopter categories. He also reported that about eighty four per cent of the farmers in low and medium adopter categories and sixteen per cent in high adopter categories followed green manuring.

Ahlawat *et al.* (1996) results of experiments in South Gujarat revealed that when *rabi* pulses were grown after paddy on residual moisture, it was not necessary to apply any fertilizers to pulses. Further, it was found that when legumes were included in cropping sequence (greengram, paddy), it reduced the nitrogen requirement of paddy by twenty five per cent.

Iqbal *et al.* (1996) noticed that high level of adoption in integrated pest management practices for cotton by the farmers was reported only in the case of avoidance of summer cotton. Removal and destruction of cotton stalks and crop residue was found highly adopted by both small and big farmers. Spray of pesticides to control sucking pests like aphids and thrips and deep ploughing was found to be high among the respondents of marginal and big farmers category. Use of pheromone traps, NPV were found to have been highly adopted by small farmers.

Shivaraj (1996) revealed that majority of the respondents had not adopted the practices of using light trap (100%), use of pheromone trap (66.25%) and use of green lace as predator (*Chrisoperla cornea*) 93.75 per cent, use of NPV (73.75%), use of neem seed kernel extract/neem based pesticide 22.50 per cent.

Balappa (1997) in his study indicated that IPM farmers realised (14.83%) more net returns (Rs. 5,362.42/ha) than non-IPM farmers (Rs. 3,401.56/ha).Further,, production function estimates indicated positive influence of plant protection chemicals in the case of IPM farmers (0.19) whereas, it was negative in the case of non-IPM farmers (0.30). The returns to scale was increasing in the case of IPM farmers (1.33) whereas, it was decreasing in the case of non-IPM farmers (0.50) as indicated by sum of output elasticities.

Israel Thomas *et al.* (1997) conducted a study on farmer to farmers' interaction in dissemination of agricultural technology with the objectives of identifying technologies used in farmer to farmer communication and to study methods of farmers' communication in dissemination of agricultural technology. They concluded that exposure of farmers to various pest symptoms and their control measures and improved methods of irrigation and water conservation techniques were found in lead better dissemination and receipt of information among the farmers. The informal visit to the neighbors' fields was an important method to communicate and receive the information from fellow farmers. The emergency situations paved the way for farmer to farmer communication.

The information from the extension workers was an important factor or communication to farmers. If these points were considered farmer to farmer communication may become an effective mechanism for disseminating agricultural technology.

Khan *et al.* (1998) studied the IPM technology adopted by Karnataka farmers in tomato and observed that those farmers, who adopted Integrated Pest Management strategy for the control of *Helicoverpa armigera*, obtained 26 per cent higher fruit yield than the non-adopters by spending less on plant protection chemicals and obtained higher returns.

Peshin and Kalra (1998) studied the adoption of IPM practices in rice crop and their economic impact at farmers' level. The study also revealed that there was appreciable difference with respect to frequency of pesticide sprays between IPM and non-IPM farmers. The average yield per unit area in IPM villages was 62.65 qt/ha as compared to 50.58 qt/ha in the non-IPM villages. The differences in pesticide sprays, expenditure on pesticides and yields were statistically significant.

Kalaskar *et al.* (2001) revealed that majority of the respondents (67.25%) were moderately aware about different PPM practices in cotton. In other words, it could be stated that quite a few (16.97%) respondents had high level of knowledge about IPM practices

Ramesh and Govind (2001) reported from their study on adoption of organic farming practices in paddy, that farmers' extent of adoption level was higher in all the organic farming practices in Pudukattai district of Tamil Nadu state especially in water management, land preparation and storage practices in paddy crop.

Bhople and Borkar (2002) in their study on bio-fertilizers farmer attitude and adoption observed that, majority of the farmers (84 %) having moderate level of knowledge about different kinds of bio-fertilizers and their associated practices. About one tenth of them were adequately equipped with the knowledge about bio fertilizers and appeared in high knowledge category.

Kale *et al.* (2003) conducted a study on correlations of adoption gap of recommended cotton technologies among small and big farmers. A sample 100 each of small and big cotton growers was studied in Jalgaon (Jamod) panchayat sameethi of Buldhana district to find out the gap in adoption of PKV Hy-2 cotton technologies. The results have shown that there was 29 per cent adoption gap in recommendation and use of PVK Hy-2 cotton technologies by farmers. The adoption gap was found to be more in respect to use of seed rate (36.32%) followed by application of fertilizers (31.04%) and plant protection chemical (30.03%). It was found to be minimum in the case of the manures (20.39%), from more only in respect of the seed rate by small (41.69%) and big (30.95%) cotton growers. It was further noted that the psychological characteristics namely, economic motivation, scientific orientation and risk preference, were found to be negative and significant in reaction with protection measures among small and big cotton growers and were thus consistently influencing the adoption of PKV Hy-2 cotton technologies. The cotton growers therefore need to be consistently persuaded and convinced about the importance of PKV Hy-2 cotton technologies for getting higher yields.

Nagaraj *et al.* (2004) conducted study on the productivity change due to application of bio-fertilizer in groundnut production. The study was conducted in Koratagere taluk of Tumakur district in Karnataka. The data pertaining to *kharif* season of 1998 was collected from 30 farms each with and without bio fertilizer application, growing JL-34 and TMV-2 variety of groundnut crop were selected randomly from three villages. The results showed a productivity change of 497.60 kg/ha, of which 36.41 per cent was due to use of bio fertilizer in groundnut production. The study also suggested that there is scope to raise productivity through application of eco-friendly technologies like bio-fertilizers.

Raghunandan (2004) conducted a study on knowledge and adoption level of soil and water conservation practices by farmers in northern Karnataka reported that, about 17.50 per cent of respondents had the complete knowledge of contour cultivation purpose. Majority of respondents possessed the knowledge of reduces soil erosion and conserves soil moisture (62.50%), followed by reduced cost of cultivation (50.00%) and directly improves soil fertility (26.25%).

2.4 Problems faced by growers in production

Thakur and Sharma (1984) reported the weaknesses of the farm sectors responsible for slow progress of agriculture. Irrigation, lack of High Yielding Varieties, very low use of fertilizers and lack of extension facilities to translate improved technology to farmers' field were found to be some of the main constraints.

Rangrao and Ray (1985), identified constraints in pulse production in different states like Bihar, Madhya Pradesh, Maharashtra, Orissa, Rajasthan and Uttar Pradesh. The factors responsible for poor production were shortage of high yielding varieties of pulses, lack of irrigation, fertilizers and pesticides in pulses, high risk and uncertainty in cultivation. The measures noticed to overcome the problems were adoption of yield –raising improved technology, introduction of short-duration pulse varieties in irrigation farming system and adoption of effective plant protection measures.

Anonymous (1986) studied the problems in increasing production of gram in Sriganaganagar district of Rajasthan during the year 1984. The constraints noticed were small size of holdings, lack of technological support, very less area under irrigation (only 2.2 per cent of total cropped area of selected holdings) due to better prospects for other crops like wheat, cotton and mustard, lack of fertilizer and pesticide use, certain natural factors like emergence of blight disease, occurrence of frost, attack of pests like termites and pod borer. The producers suffered more in case of gram as compared to wheat because of higher gram price escalations during the successive intervals of its transaction from one hand to another.

Jain and Singh (1991) estimated the growth rates for different Pulse crops in Punjab during the pre-and post-green revolution phase to examine whether the new cereal technology had got diffused to Pulses. During the pre-green revolution period area, yield and production of total Pulses registered a positive but non-significant growth rates indicating stagnation. Whereas, in the second period all the three variables gave negative growth rates which were significant in the case of area and production, denoting deceleration. Continuous substitution of area under pulses with HYV cereal crops was the main reason for the desperate performance of pulses in the post-green revolution period.

Naik (1998), while studying economics of farming systems in Uttara Kannada district, identified the problems faced by the farmers in all three agricultural regions of the district. He classified the problem broadly into production, financial, marketing and infrastructural/extension problems. The major problems faced by the farmers in the production front were shortage of labours during peak season, non-availability of chemicals and fertilizers and non-availability of improved breeds of live stock. Exploitation by commission agents and traders were the major constraints under marketing while, lack of extension facilities was the main amongst the infrastructural /extension constraints.

Vivekanand (1999) opined that agricultural development in Karnataka state had been hindered by problems such as weak research–extension network, regional imbalances, and stagnation in area under High Yielding Varieties *etc*

Ganesh (2000) classified the problems faced by the farmers under four groups *viz* production, financial, infrastructural, and marketing problems in Gazani lands of Karnataka. With respect to the production problems, majority of the farmers complained of non-availability of better variety seeds and fingerlings. Regarding financial problems, lack of funds for purchase of improved inputs was major problem. Extension problems included non-availability of package of practices. The important problem was absence of market regulation and information

Chandrashekhar *et al.* (2001) listed production constraints faced by growers in the order of importance. They were lack of technical guidance, more pest and diseases, high cost of fertilizers, high cost of plant protection chemicals, non-availability of seed materials and non-availability of fertilizers in time.

Gaddi *et al.* (2002) revealed in their study on yield gaps and constraints in the production of rabi sorghum in Bijapur and Gulbarga districts of Karnataka that the suboptimal use of plant nutrients, human labour and bullock labour on farmers' field vis-à-vis demonstration plots were the major factors conditioning yield gap.

Substandard and costly chemical fertilizer and plant nutrients, labour shortage, non-availability of desired variety seed, unfavorable climatic conditions and incidence of pest and diseases limited sorghum productivity on farmers' fields.

Ramesh (2003) studied the Agricultural Research Prioritization for Agro-climatic zones of 1, 2 and 3 of northern Karnataka. He observed that among the socio-economic constraints, fluctuations in prices of output, non-availability of agro-chemicals, non-availability of labours during peak season and unawareness of improved technology were the most severe constraints faced by the farmers in the study area. Ranking of constraints based on yield loss indicated that most of the crops across zones were most affected by rainfall, pests, diseases and weeds.

Gurunath *et al.* (2008) recognized the importance of pulses crops for their perceived ability to contribute significantly to food and nutritional security, economic growth and poverty reduction. For the study secondary data were collected from various published sources. The temporal and spatial analyses of pulses crop have revealed that there were significant variations across period and regions in terms of growth in area, production and yield of pulses crops. It was also found that there are variations in profitability of pulses crops. The results of the Tornquist-Tgeil index for total factor productivity (TFP) analyzed in terms of growth rates and trends in TFP have shown a continuous decline even after 1990s. The rate of increase in input indices has been much higher than output indices in all major pulses-growing states. Technology being major contributing factor to TFP growth, greater R&D emphasis on pulses was needed. Other factor which could make a setback on present unsustainable behavior of TFP was the price parity of pulses with competing food crops, market support and irrigation. A significant variations has been observed in yield, cost of cultivation and profits of major pulse crops .The study has suggested that policy focus may be tilted towards development of pulses crops by way of developing irrigation infrastructure, access to institutional credits, supply of inputs, adoption of technologies, particularly the use of HYV seeds, development of market infrastructure and adequate price support. This would help in a big way to improve both production and productivity of pulse crops in the country.

3. METHODOLOGY

This chapter deals with the description of the study area, the sampling procedure followed, the nature and sources of data and analytical tools and techniques employed. The methodology is presented under the following major headings.

3.1 Description of the study area

3.2 Sampling procedure

3.3 Nature and source of data

3.4 Analytical techniques employed

3.1 Description of the study area

The detailed description of the study area has been furnished as under.

3.1.1 Location and Area

Gulbarga district is situated in Northern Dry zone of Karnataka state. It lies between North latitude 17°10 and 17° 45 and between east longitude 76° 10 and 77° 45. The total Geographical area of district is 16,224 sq km occupying the second place among the districts of Karnataka. The soils of this district are deep to very deep black, medium black, sandy loam and are light textured. The annual rainfall ranges from 633.2 to 806.66 mm. The total population is 25, 64,892 with literacy percentage of 65.65 per cent. The weather in Gulbarga consists of 3 main seasons. The summer spans from late February to mid June. It is followed by the south west monsoon which spans from the late June to late September with heavy rainfall which may go up to 750mm. It is then followed by dry winter weather until mid January. Temperatures during the different seasons are summer : 38° to 44°C, Monsoon: 27° to 37°C and Winter : 11° to 26°C.

The district has a large number of tanks which, in addition to the rivers, irrigate the land. The Upper Krishna Project is a major irrigation venture in the district. Tur bajra, sugarcane, groundnut, sunflower, sesame, castor bean, black gram, jowar, wheat, cotton, ragi, bengal gram, and linseed are grown in this district.

The agro-climatic conditions are best suited for pulse crops in Karnataka State. Gulbarga district is the major pulse growing district in Karnataka having an area of about 3.79 lakh hectares with production of 1.94 lakh tones with a productivity of 539 kg /hectare. Gulbarga district is considered as “pulse bowl” of Karnataka.

The Bidar district falls under the North Eastern Transitional Zone (Zone 1) of Karnataka. Bidar district is situated between 17°35 and 18°25 North latitude and 76°42 and 77°39 East longitudes. The average annual rainfall of Bidar district is 847 mm. The rainfall is well distributed between June to October, while in the month of September the intensity of rainfall is high.

The temperature varies from 16.4°C to 38.8°C with the maximum temperature prevailing during April and May i.e. 37°C to 38.8°C and the minimum temperature in the month of December. From the middle of February, the day and night temperatures go on increasing till the end of May or beginning of June.

Mainly two types of soils are found in Bidar district namely red laterite, shallow to medium deep and deep black soils. The total geographical area of the district is 5,41,765 hectares, out of which 439,446 hectares is under cultivation (65.40 per cent). Bidar with an area of 62,667 hectares under pigeonpea with a production of 50,127 tonnes having productivity of 842 kg/hectares stands second after Gulbarga.

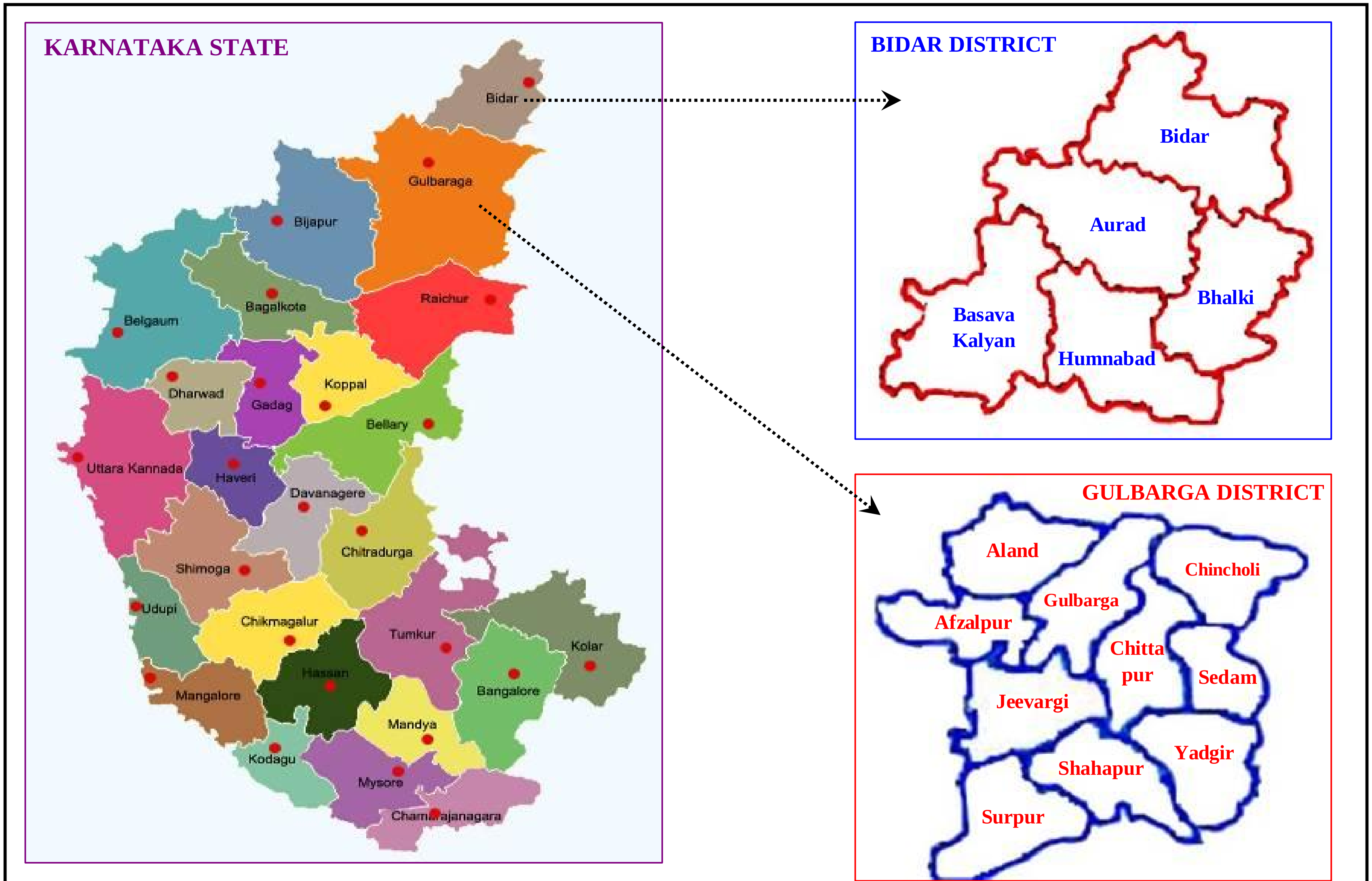

Fig 3.1: Map showing the study region

3.1.2 Land utilization pattern in Gulbarga and Bidar districts

Land utilization pattern of both Gulbarga and Bidar districts are presented in Table 3.2.

Total geographical area of Gulbarga is 16, 10,208 ha, while it is 5, 41,765 in Bidar. Forest occupies 69,089 ha of area in Gulbarga and in Bidar, it was 27,707 ha. Land not available for cultivation is further divided into non-agricultural land and barren land, which is 1,31,107 ha in Gulbarga and 46,133 ha in Bidar. Other uncultivated land occupies 51,257 ha and 44,285 ha in Gulbarga and Bidar districts respectively. Other uncultivable land is further divided into cultivable waste, permanent pastures and trees and grooves. Current fallow and others contribute towards total fallow land which is 2, 00,985 ha and 88,547 ha in Gulbarga and Bidar districts respectively. Area sown is divided into net area sown and area sown more than once, which is 11, 57,770 ha in Gulbarga and 3, 40,093 ha in Bidar district respectively.

3.1.3 Demographic features of Gulbarga and Bidar districts

Demographic features of both districts are presented in Table 3.2. Gulbarga is having a population of 25 lakh. It has literacy rate of 65.65 per cent with population density of 233 persons per square kilometer. Total population of Bidar is 17 lakh, with a population density of 312 persons per square kilometer. It has literacy rate of 71.01 per cent.

3.2 Sampling design

3.2.1 Study region and sampling

Pigeonpea cultivation is mainly concentrated in northern parts of Karnataka especially in Bidar and Gulbarga districts. Transplanted method of Pigeonpea cultivation is also mainly practiced in these two districts. Hence, the study has been conducted in Bidar and Gulbarga districts which come under zone-1 and zone -2 regions respectively in Karnataka state. A total of 120 sample farmers were selected randomly for the study which comprises 60 transplanting method producers of pigeonpea and 60 traditional methods of pigeonpea producers in Bidar and Gulbarga districts.

3.3 Nature and sources of data

Primary data with respect to factors influencing shifting over to transplanting method, costs and returns, resource use pattern in transplanting and conventional methods were collected from farmers. The problems faced by pigeonpea producers were also studied by taking their opinions. The data pertained to the crop year 2009-2010.

3.4 Analytical tools employed

1. Tabular analysis
2. Cobb-Douglas production function
3. Logit model.
4. Decomposition model

3.4.1 Tabular analysis for cost and returns

Tabular presentation technique was followed to study the economic characteristics of the two groups of the sample farmers those adopting transplanted and conventional system of pigeonpea cultivation, such as size of the land holding, cropping pattern ,cost and returns expressed by the farmers and for analyzing data elicited through opinion survey from sample farmers. The data were compared and contrasted by the help of averages.

3.4.2 Cobb-Douglas production function to analyse the resource use efficiency

The factors responsible for the difference in gross returns between transplanted system and conventional system of pigeonpea cultivation was studied using Cobb-Douglas function.

Table 3.1: District-wise area, production and productivity of pigeonpea during 2008-09

Sl. No.	Districts	Area (hectares)	Production (tones)	Productivity (kg/ha)
1.	Bagalkote	1056	1056	274
2.	Bangalore – urban	714	377	556
3.	Bangalore – rural	1340	1419	1115
4.	Belgaum	4237	1618	402
5.	Bellary	9640	4368	402
6.	Bidar	62667	50127	842
7.	Bijapur	48686	19472	421
8.	Chamarajanagar	2349	1185	531
9.	Chickballapur	8247	4098	523
10.	Chikmagalur	597	315	556
11.	Chitradurga	9533	4039	446
12.	Dakshina kannada	0	0	0
13.	Davanagere	4432	3604	856
14.	Dharwad	3549	2677	794
15.	Gadag	1365	401	309
16.	Gulbarga	379769	194461	559
17.	Hassan	1757	611	366
18.	Haveri	2332	1309	591
19.	Kodagu	0	0	0
20.	Kolar	3200	1800	592
21.	Koppal	9479	4007	445
22.	Mandya	1163	614	556
23.	Mysore	3136	1594	535
24.	Raichur	13531	3535	275
25.	Ramanagar	3148	2389	671
26.	Shimoga	530	280	556
27.	Tumkur	19497	10409	562
28.	Udupi	0	0	0
29.	Uttara kannada	68	36	556
	Karnataka	**5,96,622**	**3,15,020**	**556**

Source: Karnataka state at a Glance, Directorate of Economics and Statistics, Bangalore, Karnataka. 2008-2009

Table 3.2: Land utilization patterns of Gulbarga and Bidar districts

(Area in ha)

Particulars	**Gulbarga**	**Bidar**
Geographical area	16,10,208	5,41,765
Forest cover	69,089	27,707
Land not available for cultivation	**1,31,107**	**41133**
a. non-agricultural .land	67,952	22006
b. barren	63,115	19127
Other uncultivated land	**51,257**	**44,285**
a. Cultivable waste	11,802	19382
b. Permanent pasture	37,610	13964
c. Trees and groves	1,845	10969
Fallow land	**2,00,985**	**88,547**
a. Current	1,77,990	47028
b. Others	22,995	41,519
Area sown	**14,44,923**	**4,00,182**
a. Net	11,57,770	3,40,093
b. More than once	2,87,153	60,089

Source: DES, Karnataka 2008-09

Table 3.3: Gulbarga and Bidar districts at a glance

Particulars	Gulbarga		Bidar	
Area in (sq.kms)	16224.0		5448.0	
Total population*	25,64,892		17,00,018	
a. Male*	13,07,061		8,70,850	
b. Female*	12,57,831		8,29,168	
Population density (no/sq.km)*	233		312	
Literacy rate (%)				
a. Male *	75.11		79.94	
b. Female*	55.87		61.66	
Total	65.65.0		71.01	
Normal rainfall (mm)	839		886	
Number of rainy days	45		49	
Agricultural holdings (Ha)	Numbers	Area	Numbers	Area
Marginal (<1 ha)	1,28,435	76,071	67,543	35,491
Small (1-2 ha)	2,03,718	2,99,472	92,081	1,31,175
Semi-medium (2-4 ha)	1,61,974	4,43,413	57,165	1,53,022
Medium (4-10 ha)	71,044	4,15,217	19,035	1,09,696
Large (>10 ha)	10,722	1,47,911	2585	34,335
Total	5,75,793	13,82,084	2,38,409	4,66,717

Source: Karnataka state at a Glance, 2009

* Population as per 2011 census

Fig. 3.2: Flow chart of transplanted method

To sort out the contribution of technology and resource use difference to the total income difference between these two systems the log linear production function (Cobb-Douglas form) was fitted. This was done with a view to determine the extent to which the important resources that have been quantified, explain the variability in the gross returns of the two systems of pigeonpea cultivation and to determine whether the resources were optimally used in these cropping systems. Cobb-Douglas type of function has been the most popular of all possible algebraic forms in the farm firm analysis as it provides comparison, adequate fit, computational feasibility and sufficient degrees of freedom. The linear production function (Cobb-Douglas form) was specified for both systems as below.

$$Y = aX_1^{b_1}X_2^{b_2}X_3^{b_3}X_4^{b_4}e^{\mu} \text{---------(1)}$$

The production function was specified on per hectare basis, since the purpose is to compare the total income difference (per unit area). In the above model,

Y = Gross returns (rupees/hectare)

X_1 = Seeds (rupees/ hectare)

X_2 = Fertilizers and manures (rupees/ hectare)

X_3 = Plant protection chemicals applied (rupees/ hectare)

X_4 = Labour (rupees/ hectare)

μ = Random disturbance term in conformity with the OLS assumptions

a = Scale parameter

b_i = Slope parameter of regression function (this also serves as the production elasticity's of respective inputs)

3.4.3 Decomposition model to identify the factors responsible for difference in gross returns between conventional and transplanted systems.

Before going into decomposition analysis of the difference in gross returns between conventional and transplanted system of pigeonpea cultivation, one must ensure that there is a structural break or not in the production relations between the two systems. To identify the structural break, if any, in the production relations between conventional and transplanted systems, output elasticities were estimated by OLS, fitting log-linear regression, separately for conventional and transplanted system of pigeonpea cultivation. The pooled regression analysis was run in combination with conventional and transplanted systems including dummy variable for transplanted system. Dummy variable was quantified as 0 for conventional and 1 for transplanted system.

Following equations were derived from afore mentioned equation was estimated for identifying structural break.

$$\ln Y_t = \ln\delta_0 + \delta_1 \ln X_1 + \delta_2 \ln X_2 + \delta_3 \ln X_3 + \delta_4 \ln X_4 + \mu_t \quad \text{-------------- (2)}$$

$$\ln Y_c = \ln\beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \mu_c \quad \text{-------------- (3)}$$

$$\ln Y_d = \ln\gamma_0 + \gamma_1 \ln X_1 + \gamma_2 \ln X_2 + \gamma_3 \ln X_3 + \gamma_4 \ln X_4 + \gamma_5 \ln X_5 + \mu_d \quad \text{-------------- (4)}$$

Equations 2 and 3 represent transplanted and conventional system respectively. Equation 4 is the pooled equation including dummy variable for transplanted system. If the regression coefficient of the dummy is significant, then there is structural break in production relations with the adoption of transplanted system.

To decompose the total productivity difference between for transplanted system and conventional system into their constituent sources, Bisaliahs's (1976) output decomposition model was used. The model was based on production function approach.

Theoretical framework

Figure 3.3 depicts a diagrammatic presentation of the total productivity gap between transplanted and conventional systems. Let the production function for the two systems are f_1 and f_2 for conventional and transplanted systems respectively. Further, let X_1 and X_2 be the levels of input use for which the corresponding outputs are Y_1 and Y_2 respectively. Hence the total difference in productivity is (Y_2-Y_1), from an input use of (X_2-X_1). This total productivity differential could be partitioned that accountable to technology and to difference in the levels of input used. The difference due to technology can be further portioned to neutral and non-neutral components. In the figure, the dotted line (f_3) having its slope of f_1 represents the demarcation between neutral and non-neutral technological gap. The difference between f_2 and f_3 is non-neutral technological change, brought out due to the ability of transplanted system to convert input to output more efficiently. The difference between f_3 and f_2 represents the non-neutral technological component and (Y_2-Y_1) is total technological gap. Hicks defined technological change as neutral if due to a technological change in output, the factor proportions remain constant. Although the concept of factor proportions possesses some theoretical interest as a reference datum, in practice technological change usually involves a change in factor proportions (Ghatak and Ingersent, 1984). Therefore, the amount of technological change constrained by fixed factor proportions is termed as neutral change and the complement (ie. the total technological change minus the neutral technological change) is attributed to non-neutral technological change.

Empirical Model

The model requires the production function to be specified in unit area basis. Hence the log linear form of Cobb-Douglas production in equations (2) and (3) were reproduced here.

$$\ln Y_t = \ln\beta_0 + \beta_1\ln X_1 + \beta_2\ln X_2 + \beta_3\ln X_3 + \beta_4\ln X_4 + \mu_t \quad \text{-----------(5)}$$

$$\ln Y_c = \ln\gamma_0 + \gamma_1\ln X_1 + \gamma_2\ln X_2 + \gamma_3\ln X_3 + \gamma_4\ln X_4 + \mu_c \quad \text{------------(6)}$$

These equations were estimated using OLS technique. Since the production function is on per unit area basis, the multicollininarity was not a problem as indicated by the zero order correlation matrix. Taking the difference between equation (5) and (6) and performing slight algebraic manipulations, and rearrangement of some terms, the following decomposition model was arrived at,

$$\ln Y_t-\ln Y_c = \{\ln\beta_0-\ln\gamma_0\} + \{(\beta_1-\gamma_1)\ln X_{1c} + (\beta_2-\gamma_2)\ln X_{2c} + (\beta_3-\gamma_3)\ln X_{3c} + (\beta_4-\gamma_4)\ln X_{4c}\} + \{\beta_1(\ln X_{1t}-\ln X_{1c}) + \beta_2(\ln X_{2t}-\ln X_{2c}) + \beta_3(\ln X_{3t}-\ln X_{3c}) + \beta_4(\ln X_{4t}\ln X_{4c}) + (\mu_t-\mu_c)\text{---(7)}$$

Rearranging (7) might also be written as,

$$\ln Y_t - \ln Y_c = (\ln\beta_0-\ln\gamma_0) + \{(\beta_1-\gamma_1)\ln X_{1c} + (\beta_2-\gamma_2)\ln X_{2c} + (\beta_3-\gamma_3)\ln X_{3c} + (\beta_4-\gamma_4)\ln X_{4c} + + \{\beta_1\ln(X_{1t}/X_{1c}) + \beta_2\ln(X_{2t}/X_{2c}) + \beta_3\ln(X_{3t}/X_{3c}) + \beta_4\ln(X_{4t}/X_{4c})\} + (\mu_t-\mu_c) \text{-----------(8)}$$

The left hand side of the equation gives the total difference in gross returns expressed as percentage over conventional system. The natural logarithm of the ratio of per hectare output of the transplanted system to that of conventional system is approximately a measure of percentage difference in output of the two systems. The first bold bracket terms on the right hand side, the natural logarithm of the constant terms, is the gap attributable to the neutral component of the technology. It is a measure of neutral technology gap. The second bold bracket term is the gap attributable to the non-neutral component of the technology weighed by input use for conventional. That is a measure of non-neutral technology gap, after adjustment in the levels of input use between the two systems. The third bold bracketed term refers to the gap attributable to difference in the input use weighed by the slope coefficients of the productivity functions fitted for transplanted systems. Hence, it is the gap due to difference in the levels of input use between systems after making due adjustment for production elasticities of different inputs. The last component is the random error term which the model could not take into account (Feder and O'Mare, 1981).

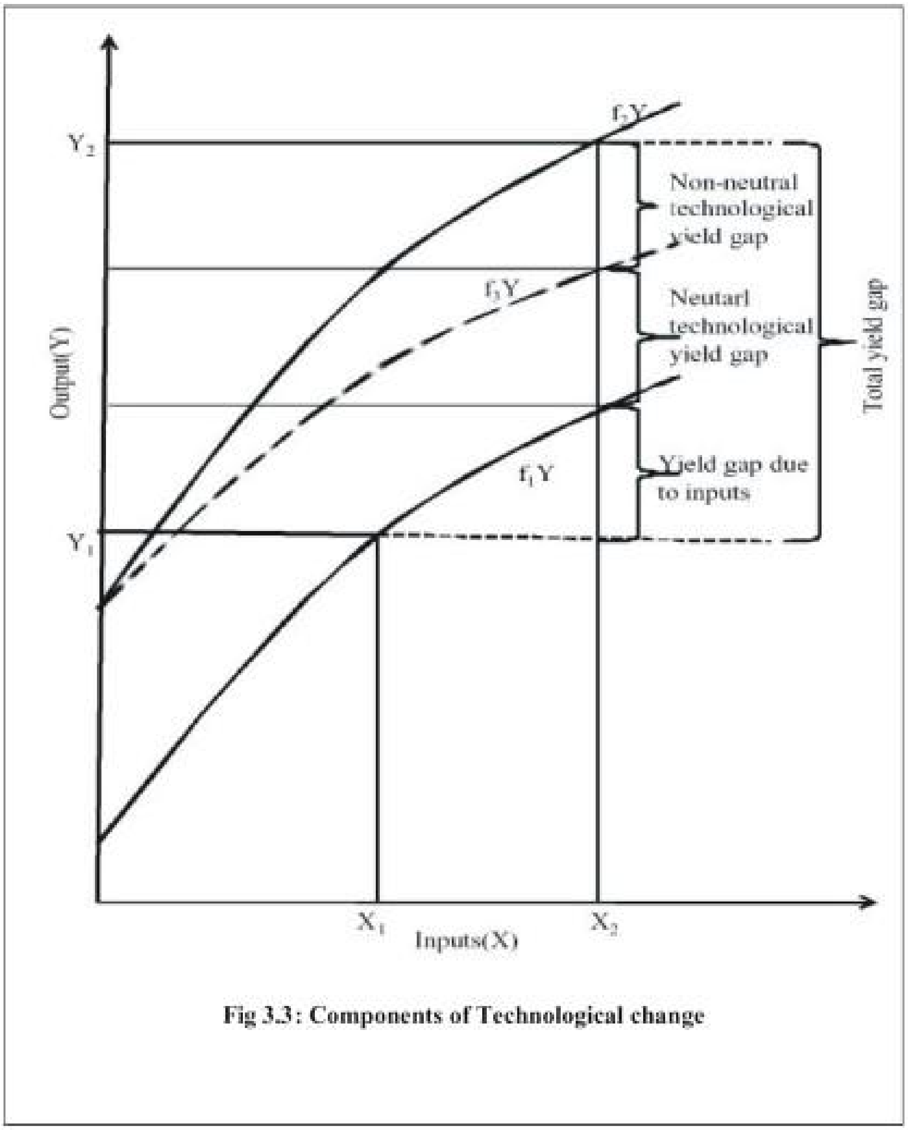

Fig.3.3: Components of Technological change

3.4.4 Logit model to study the factors influencing in adoption of transplanted method of pigeonpea cultivation

Farmers' adoption of transplanted system of pigeonpea cultivation was studied using logit model. This study utilized a logistic regression model to empirically quantify the relative influence of various factors in the decision of the respondents to adopt transplanted system of pigeonpea cultivation or conventional method of pigeonpea cultivation.

Logit model

Since logit model is used in the present study an elaboration on this model is required before specifying the model. The influence of socio economic factors on adoption, willingness to pay for something, participation in activities etc. were analyzed by several studies (Shakya and Flinn, 1985 and Thomas et al, 1990). The answer to the particular question put to the farmer was dichotomous which will not allow variation within these limits. The linear probability model specification of the dichotomous choice is

$$Y_i = X_i\beta + \mu_i \text{------(9)}$$

The dependent variable Y_i takes the value of one if the decision maker selects the first option, zero otherwise. X_i is a matrix of regressors with N observations and K estimable coefficients, β is a Kx1 vector of parameters; and μ_i is the i^{th} identically and independently distributed random disturbance with zero mean (Polson and Spensor, 1991). While the linear probability model is computationally and conceptually easier than the other two, its specification creates estimation problems with the application of Ordinary Least Squares (OLS) (Lee and Stewart, 1983 and Capps and Crammer, 1985) and many times violates the basic tenets of probability (Mingche, 1977). An inherent deficiency of the model is the heteroscedastic disturbance term. Though the heteroscedastic problem can be overcome through monotonic transformation, its efficiency by weighted least squares also depends on conditions applied. These deficiencies could be overcome through the use of monotonic transformation estimated through likelihood approach (logit and probit specification), which guarantees that prediction lies between the intervals 0 and 1(Capps and Crammer, 1985). While probit model assumes the standard cumulative distribution function, the logit follows logistic distribution function for the probability.

Univariate logit and probit models and their extensions have been used extensively to study the adoption behaviour of farmers and consumers (Schimdt and Strauss, 1975; Polson and Spensor,1991 and Kiresur et al. 1999). In the present study the dependent variable is a dichotomous one and the logit model was employed.

The logit model specified was as

$$T_i = f(Z_i) = \frac{e^{Z_i}}{1+e^{Z_i}} \text{ for } -\infty < Z < \infty \text{ and } Z_i = X_i^{I} \text{----------(10)}$$

Where, f (Z_i) is the logistic density function for logit model. Let P_i be the probability that a farmer opts for transplanted method of pigeonpea cultivation.

As per the above logistic function,

P(C/X) = The probability of an individual farmer opines in favour of transplanted method of pigeonpea cultivation

$$= \frac{1}{1+e^{-Z_i}} \text{ ---------------(11)}$$

$$1\text{-P(C/X)} = 1 - \frac{1}{1+e^{-Z_i}} \text{------------(12)}$$

= The probability of an individual opines against transplanted method of pigeon pea cultivation or in other words opts for conventional method of pigeonpea cultivation.

The Odd's ratio – It is the ratio of the probability of occurrence of an event to the probability of non-occurrence of that event, which is given as under.

$$\text{Odd's ratio} = [\{P(C/X)\} / \{1\text{-}P(C/X)\}] = e^{+Z_i} \text{----------------(13)}$$

Take logarithm on both sides,

$$\ln [\{P(C/X)\} / \{1-P(C/X)\}] = Z_i = X_i^I \beta + E \text{--------------}(14)$$

Where, β= vector of response coefficients

E= vector of random disturbance

The specific logit model estimated to predict the 'odds' of a farmer responding in favour of adoption of transplanted method of pigeonpea cultivation is given by

$$\left[\frac{\left\{P\left(\frac{C}{X}\right)\right\}}{\left\{1-P\left(\frac{C}{X}\right)\right\}}\right] = \propto + \sum_{i=1}^{7} \beta_i X_i + \mu \text{------}(15)$$

Where,

X_1 = Age of the farmer (years)

X_2 = Education (years)

X_3 = Income level (Rs)

X_4 = Area under pigeonpea (hectares)

X_5 = Irrigation availability (yes/no)

X_6 = Extension contact (yes/no)

X_7 = Family labour availability (no)

Concepts related to evaluation of transplanted and conventional method

The total costs were divided into three broad categories:

1. Variable Costs
2. Fixed Costs
3. Marketing Costs

Variable costs: The variable costs include cost of seed, fertilizers, wages of human and bullock labour, plant protection components and interest on operational capital at the rate of nine per cent per annum.

Interest on working capital: This was calculated on the entire working cost of the enterprise at the prevailing bank rate interest of nine per cent per annum and was computed for half of the cropping period.

Fixed costs: These include depreciation on farm implements and machinery, interest on fixed capital and land revenue. The measurement and definitions of fixed cost components are as follows.

Depreciation charges: Depreciation on each capital equipment and machinery owned by the farmers and used for land cultivation was calculated for individual farmer based on the purchase value using the straight line method

$$\text{Annual Depreciation} = \frac{\text{Original Cost} - \text{Junk Value}}{\text{Expected Life of the Asset (in no. of years)}}$$

Interest on fixed capital: Interest on fixed capital was calculated at 13 per cent per annum, which is the prevailing rate of investment credit. The items considered under fixed capital are implements and machinery.

Land revenue: Actual land revenue paid by the farmers was considered.

Land rent: The prevailing land rents for agricultural enterprises were imputed for the sample, since all land holdings were observed to be owner operated.

Marketing costs: The actual marketing charges incurred by the farmers in marketing of red gram were considered. These marketing costs include transportation costs and miscellaneous charges.

Cost of cultivation: It is the sum of variable costs, fixed costs and marketing cost expressed on per hectare basis.

Gross returns: Gross returns were obtained by multiplying the total product with its unit value.

Net returns: Net returns were obtained by deducting the total costs incurred from the gross returns obtained.

Returns to cost ratio: Returns to cost ratio was obtained by dividing the gross returns by cost of cultivation.

4. RESULTS

The necessary data were collected from the sample farmers spread over Gulbarga and Bidar districts of Northern Karnataka. The data was processed and analyzed using statistical tools and techniques, to draw meaningful conclusions. The major findings of the study were presented in this chapter under the following headings.

4.1 General characters of the sample farmers in the study area

4.2 Cost involved in cultivation of pigeonpea in transplanted and conventional system

4.3 Returns in transplanted and conventional system of pigeonpea cultivation

4.4 Resource use efficiency in the case of transplanted and conventional system of pigeonpea production

4.5 Decomposition analysis

4.6 Factors influencing in adoption of transplanted system of pigeonpea cultivation

4.7 Problems of pigeonpea growers

4.1 General characters of the sample farmers in the study area

An understanding of general characters of the sample farmers is expected to provide a bird’s eye view of the general features prevailing in the study are. Therefore, an attempt has been made in the study to analyse some of the important characters of the sample farmers. The general characters of the respondents were presented in Table 4.1.

In the case of transplanted system of pigeonpea growers, average age was found to be 41 years, while it was 45 years in the case of conventional system pigeonpea growers. In both the cases, agriculture was the major occupation. It could be further observed that 80 per cent of the sample farmers in the case of transplanted system were literate, while it was accounted to 75 per cent in the case of conventional pigeonpea growers. Literates having their education ranging from primary to college level.

From the table, it could be seen that average family size in the case of transplanted farmers was 7 members, while it was 6 in conventional pigeonpea growers. Average land holding in the case of transplanted pigeonpea growers is about 8.17 hectares, of which 4.76 hectares was dry and rest found to be irrigated. Conventional pigeonpea growers had an average landholding of 6.56 hectares, of which 4.96 hectares was dry and remaining 1.60 hectares was found to be irrigated.

4.1.1 Cropping pattern of the sample farmers

From Table 4.2 it was observed that both categories of farmers were growing number of crops on their farm. Pigeonpea, greengram, bengalgram, sunflower, jowar, chickpea were found to be the major crops and groundnut, wheat, sugarcane were the other crops.

In the case of transplanted pigeonpea growers pigeonpea, greengram, bengalgram, sugarcane were the crops cultivated during *kharif*, among these pigeonpea, greengram and bengalgram were major crops with an average are of 5.95, 0.72 and 0.59 hectares, respectively.

In *rabi* season, jowar, chickpea and wheat were the major crops with average area of 0.97, 0.86 and 0.37 hectares respectively. Farmers with access to irrigation facilities cultivated vegetables in summer, with an average area of 0.47 hectare. Banana was the horticultural crop with an average area of 0.05 hectare.

Pigeonpea, greengram, bengalgram, sunflower and sugarcane were the crops grown by conventional farmers during *kharif*. Pigeonpea occupies highest average area of 4.78 hectares, while sunflower had an average area of 0.37 hectare and sugarcane 0.31 hectare

In *rabi* season, jowar, chickpea, wheat and groundnut were the major crops. In which, jowar has an average of 1.38 hectares, chickpea 0.58 hectares and both groundnut and wheat occupies an average area of 0.20 hectare. Farmers with irrigation facilities grown vegetables in an average area of 0.39 hectare.

Table 4.1: General characters of the sample farmers

Sl. No.	Particulars	Unit	Transplanted	Conventional
			n=60	n=60
1	Age	Years	41	45
2	Education			
	Illiterate	Nos.	12 (20.00)*	15 (25.00)
	Primary	Nos.	18 (30.00)	21 (35.00)
	High school	Nos.	15 (25.00)	14 (23.40)
	College	Nos.	15 (25.00)	10 (16.60)
3	Occupation			
	Agriculture as main occupation	Nos.	55 (91.66)	50 (83.33)
	Agriculture as subsidiary occupation	Nos.	5 (58.33)	10 (16.66)
4	Family size	Nos.	7	6
5	Land holdings			
	Irrigated	Hectares	3.41	1.60
	Dry land	Hectares	4.76	4.96
	Total	Hectares	8.17	6.56

* Figures in parentheses indicate percentage

Table 4.2: Cropping pattern of the sample farmers

Cropping season	Transplanted system		Conventional system	
	Area (hectares)	**Percentage**	**Area (hectares)**	**Percentage**
Kharif				
Pigeon pea	5.59	68.39	4.78	72.76
Green gram	0.74	8.76	0.28	4.36
Black gram	0.59	7.21	0.25	3.85
Sunflower	0.34	4.24	0.37	5.63
Sugarcane	0.30	3.75	0.31	4.76
Others	0.62	7.62	0.56	8.62
Total	**8.17**	**100**	**6.57**	**100**
Rabi				
Jowar	0.97	41.05	1.38	51.19
Chickpea	0.86	36.33	0.58	21.71
Wheat	0.37	15.56	0.20	7.54
Ground nut	-	-	0.20	7.54
Others	0.16	7.04	0.32	12.00
Total	**2.36**	**100**	**2.69**	**100**
Summer				
Vegetables	0.47	100	0.39	100
Horticultural crops				
Banana	0.05	100	-	-
Gross cropped area(Ha)	11.06		9.65	
Total land holdings (Ha)	8.17		6.57	
Cropping intensity (%)	135.37		146.91	

4.1.2 Input use pattern in transplanted and conventional methods of pigeonpea cultivation

The details regarding input use pattern are discussed as under

4.1.2.1 Input use pattern in transplanted method

Input use pattern of the transplanted method of pigeonpea cultivating farmers was presented in Table 4.3. Seeds, farm yard manure, chemical fertilizers, polythene bags for raising seedlings and plant protection chemicals were the input used in this method.

In this method pigeonpea seedlings were raised in the nursery, for which an average of 4.60 kg per ha of seeds were used by the sample farmers. During seedlings preparation, 10 quintals of farm yard manure was used. Chemical fertilizers like, nitrogen 87.50 kg per ha and phosphorous 57.50 kg per ha were used by the farmers in two doses i.e one basal dose after transplanting into the main field and second dose after 40-45 days after transplanting. For raising seedlings an average of 11.25 kg of polythene bags (6"x6") were used for one hectare area. To take up plant protection measures, chemicals worth rupees 4245.82 were used by the farmers in this method.

4.1.2.2 Input use pattern in conventional method

From the results presented in Table 4.4, it was found that 12.25 kg per ha of seeds were used by the farmers for sowing and 43.70 kg nitrogen and 52.90 kg of phosphorous per ha applied. Chemical pesticides worth Rs. 4668.75 were used to take up plant protection measures by the farmers.

4.2.3 Labour use pattern in transplanted and conventional methods of pigeonpea cultivation

4.2.3.1 Labour use pattern in transplanted method

Labour used to carry out different farm operations on hectare basis in transplanted method of pigeonpea cultivation was presented in Table 4.5. A total of 87.90 man days of human labour, 18.55 pair days of bullock labour and 3.56 hours of machine labour were utilized by the farmers.

In ploughing operation, 2.70 man days of human, 2.70 pair days of bullock and 1.90 hours of machine labour were used. For harrowing 4.80 man days of human, 4.80 pair days of bullock and 0.80 hours of machine labour were employed. Transportation of farm yard manure required 1.20 man days of human, 1.20 pair days of bullock labour.

Seedling preparation and transplanting them into the main field were the major operations requiring more of human labour in transplanting method of pigeonpea cultivation. Seedling preparation and transplanting them into main field requires 22.50 and 15.95 man days of human labour respectively. Fertilizer application, clipping and hand weeding needs 2.80, 3.20 and 9.40 man days of human labour respectively. Inter cultivation operation involves 7.35 man days of human labour and 7.35 pair days of bullock labour. Spraying requires 5.20 man days of human labour. Harvesting and transportation needs 12.80 man days of human, 2.50 pair days of bullock and 0.86 hours of machine labour.

4.2.3.1 Labour use pattern in conventional method

In conventional method, a total of 45.36 man days of human labour, 19.53 pair days of bullock labour and 5.35 hours of machine labour were utilized by the farmers to carry out farm operations on one hectare land. Results have been presented in Table 4.6

Ploughing was done by 2.65 man days of human labour, 2.65 pair days of bullock labour and 2.0 hours of machine labour. Harrowing was carried out by 4.90 man days of human labour, 4.90 pair days of bullock labour and 0.90 hours of machine labour. Sowing operation was carried out by using 3.50 man days of human, 3 pair days of bullock and 1.50 hours of machine labour. Fertilizer application and hand weeding was done by 4.20 and 8.85 man days of human labour respectively. Inter cultivation required 7.17 man days of human labour, 6.98 pair days of bullock labour. Spraying was carried out by using 6.20 man days of human labour. Harvesting and transportation was done by 7.89 man days of human, 2.00 pair days of bullock and 0.95 hours of machine labour.

Table 4.3: Input use pattern in transplanted method

(per ha)

Sl. No.	Particulars	Units	Quantity
1.	Seeds	kg	4.60
2.	Human labour	Man days	87.90
3.	Bullock labour	Pair days	18.55
4.	Machine labour	Hours	3.56
5.	Farm yard manure	Quintals	10.00
6.	Chemical fertilizer		
	N	kg	87.50
	P	kg	57.50
7	Polythene bags (6'' X 6")	kg	11.25
8	Plant protection chemical	Rs	4245.82

Table 4.4: Input use pattern in conventional method

(per ha)

Sl. No.	Particulars	Units	Quantity
1.	Seeds	Kg	12.25
2.	Human labour	Man days	45.36
3.	Bullock labour	Pair days	19.53
4.	Machine labour	Hours	5.35
5.	Chemical fertilizer		
	N	Kg	43.70
	P	Kg	52.90
6	Plant protection chemical	Rs	4668.75

Table 4.5: Labour use pattern in transplanted method

(per ha)

Operations	Human labour		Bullock labour		Machine labour	
	Mandays	**Percentage**	**Pair days**	**Percentage**	**Machine hours**	**Percentage**
Ploughing	2.70	3.07	2.70	13.40	1.90	53.37
Harrowing	4.80	5.46	4.80	23.82	0.80	22.47
Transportation of FYM	1.20	1.37	1.20	5.96	0	0
Spreading of Fym	0	0	0	0	0	0
Seedling preparation	22.50	25.60	0	0.00	0	0
Sowing/transplanting	15.95	16.21	0	0.00	0	0
Fertilizer application	2.80	3.19	0	0.00	0	0
Clipping	3.20	3.64	0	0.00	0	0
Hand Weeding	9.40	10.69	0	0.00	0	0
Intercultivation	7.35	8.36	7.35	36.48	0	0
Spraying	5.20	5.92	0	0.00	0	0
Harvesting and transportation	12.8	14.56	2.50	12.41	0.86	24.15
Total	**87.90**	100.00	**18.55**	100.00	**3.56**	100

Table 4.6: Labour use pattern in conventional method

(per ha)

Operations	Human labour		Bullock labour		Machine labour	
	Mandays	**Percentage**	**Pair days**	**Percentage**	**Machine hours**	**Percentage**
Ploughing	2.65	5.84	2.65	13.57	2.00	37.38
Harrowing	4.90	10.80	4.90	25.09	0.90	16.82
Transportation of FYM	0.00	0.00	0.00	0.00	0	0.00
Spreading of FYM	0.00	0.00	0.00	0.00	0	0.00
Seedling preparation	0.00	0.00	0.00	0.00	0	0.00
Sowing/transplanting	3.50	7.72	3.00	15.36	1.50	28.04
Fertilizer application	4.20	9.26	0.00	0.00	0	0.00
Clipping	0.00	0.00	0.00	0.00	0	0.00
Hand Weeding	8.85	19.51	0.00	0.00	0	0.00
Intercultivation	7.17	15.81	6.98	35.74	0	0.00
Spraying	6.20	13.67	0.00	0.00	0	0.00
Harvesting and transportation	7.89	17.39	2.00	10.24	0.95	17.76
Total	**45.36**	100.00	**19.53**	100.00	**5.35**	100.00

4.2 Cost involved in cultivation of pigeonpea in transplanted and conventional system

Per hectare cost of cultivation of pigeonpea in the case of transplanted and conventional system of pigeonpea growers have been presented in Table 4.7

Persual of the table indicated that total cost of cultivation in transplanted system was found to be higher than that of conventional system. The average cost of cultivation in the case of transplanted system of pigeonpea was Rs. 39382.28 as against Rs.30819.53 in conventional system of pigeonpea. The cost of fertilizers and manures, human labour, seed treatment were the differing factors in the cost in the case of transplanted system of pigeonpea pea cultivation. In the total cost, variable costs formed a major share of Rs. 25892.65 and Rs.17527.63 accounting for 65.74 and 56.87 per cent in the case of transplanted and conventional system of pigeonpea cultivation, respectively.

In the case of transplanted system of pigeonpea growers, the variable cost mainly comprised of human labour, plant protection chemicals, bullock labour and fertilizers and manures, which were Rs. 9588.75, Rs.4245.82, Rs. 3760.40 and Rs. 3080.40, accounting for 24.34, 10.78, 9.55 and 7.82 per cent of the total cost of cultivation.

The expenditure on human labour was found to be an important item in total cost of cultivation in the case of transplanted farmers. The other variable costs include cost of seeds, cost of seed treatment, cost of machine labour, cost of polyethylene bag and interest rate on working capital accounted for Rs. 388.75, Rs. 199.15, Rs. 1427.07, Rs.1064.37 and Rs. 2137.92 representing 0.98, 0.50, 3.62, 2.70 and 5.43 per cent, respectively of the total cost of cultivation of pigeonpea in the case of transplanted system.

The cost of cultivation of pigeonpea in the case of conventional system, variable costs mainly comprised of cost of plant protection chemicals, human labour, bullock labour, which were Rs. 4668.75, Rs. 3762.50 and Rs. 3122.90 accounting for 15.15, 12.23 and 10.13 per cent of the total cost of cultivation, respectively. The expenditure on plant protection chemicals was found to be an important item in the total cost of cultivation in conventional pigeonpea growers. The other variable costs include cost of seeds, cost of fertilizers and manures, cost of machine labour and interest rate on working capital, which accounted for Rs. 588.75, Rs. 1587.50, Rs. 2350.00, Rs. 1447.22 contributing 1.91, 5.15, 7.62 and 4.70 per cent of the total cost of cultivation.

The share of fixed cost in total cost of cultivation in the case of transplanted pigeonpea growers was 34.25 per cent (Rs. 13489.63) and in the case of conventional pigeonpea growers 43.12 per cent (Rs. 13291.88). Among the items of fixed cost, the rental value of the land had a maximum share in the total cost of cultivation in both transplanted and conventional farmers.

4.3 Returns in transplanted and conventional method of pigeonpea cultivation

The average yield level, market price, marketing cost and net returns were presented in Table 4.8

The per hectare average yield of pigeonpea on transplanted farm (26.25 qtls) was higher than that of conventional system of pigeonpea growers (15.25 qtls). The average market price in transplanted was slightly lower (3600/qtl) than that of conventional system. Total marketing cost per hectare in transplanted pigeonpea growers was Rs. 1706.25 as against Rs. 915.00 in the case of conventional pigeonpea growers.

The returns structure in transplanted pigeonpea growers revealed that gross returns per hectare was higher i.e Rs. 93485.85 as against Rs. 56382.30 in the case of conventional pigeonpea growers. The net returns on both systems were found to be positive *i.e.*, Rs. 54103.25 and Rs. 25562.78 in transplanted and conventional system, respectively. Though, the per quintal price in transplanted was lower, the net returns were higher than conventional system because of higher yields. The returns to cost ratio was higher in the case of transplanted (2.37) compared to conventional system of pigeonpea growers (1.82).

Table 4.7: Cost involved in transplanted and conventional method of pigeon pea cultivation

(Rs./ha)

Sl. No.	Particulars	Transplanted		Conventional	
A	**Variable costs**	**Cost**	**Per cent to total cost**	**Cost**	**Per cent to total cost**
1	Seeds	388.75	0.98	588.75	1.91
2	Seed treatment chemicals	199.15	0.50	0	-
3	Fertilizers and manures	3080.4	7.82	1587.5	5.15
4	Plant protection chemicals	4245.825	10.78	4668.75	15.15
5	Human labour	9588.75	24.34	3762.5	12.23
6	Bullock labour	3760.4	9.55	3122.9	10.13
7	Machine labour	1427.075	3.62	2350	7.62
8	Polythene bags	1064.375	2.70	0	-
9	Interest on working capital @ 9 percent	2137.925	5.43	1447.225	4.70
	Sub total (A)	**25892.65**	**65.74**	**17527.63**	**56.87**
B	**Fixed costs**				
1	Land revenue	125	0.31	125	0.40
2	Rental value of the land	10000	25.40	10000	32.44
3	Depreciation	1237.5	3.14	1062.5	3.44
4	Interest on fixed capital@ 13 per cent	2127.125	5.40	2104.375	6.82
	Subtotal (B)	**13489.63**	**34.25**	**13291.88**	**43.12**
	Total cost of cultivation (A+B)	**39382.28**	**100.00**	**30819.53**	**100.00**

Table 4.8: Returns in transplanted and conventional method of pigeonpea cultivation

Sl. No.	Particulars	Transplanted	Conventional
1.	Yield (quintals per hectare)	26.25	15.25
2.	Market price (Rs. per quintal)	3600.00	3700.00
5.	Total marketing cost (Rs. per hectare)	1706.25	915.00
6.	Gross returns (Rs. per hectare)	93485.85	56382.30
7.	Cost of cultivation (Rs. per hectare)	39382.28	30819.53
8.	Net returns (Rs. per hectare)	54103.25	25562.78
9.	Returns to cost ratio	2.37	1.82

4.4 Resource use efficiency in the case of transplanted and conventional method of pigeonpea production

Production functions were estimated using cross sectional data from the transplanted and conventional farmers' data to assess the degree of influence of the inputs on pigeonpea output.

While studying the economics of pigeonpea cultivation in transplanted and conventional system, it was noticed that seeds, human labour, bullock labour, fertilizers, plant protection chemicals and machine labour were the important inputs used. Polythene bags for raising seedlings of pigeonpea and seed treatment chemicals were the additional items in the case of transplanted system.

Seeds (which include polythene bag cost in the case of transplanted method), labour (human, bullock and machine), fertilizers and manures and plant protection chemicals were taken as independent variables in the model to estimate the functional relationship between dependent and independent variables.

Details of production function estimates have been presented in Table 4.9. As indicated in table, the coefficient of multiple determination (R^2) was 0.72 and 0.69 for conventional and transplanted system of pigeonpea growers respectively. Hence, for the conventional and transplanted farmers, the variables included in the model had explained 72 and 69 per cent of variations in gross returns of pigeonpea respectively.

In the case of conventional pigeonpea growers, the output elasticities for seeds and plant protection chemicals were negative (-0.098 and -0.034) and significant at 1 and 5 per cent confidence level respectively. Whereas, fertilizers and manures (0.02) was positive and significant at 1 per cent confidence level, labour (0.035) was positive and found to be significant at 5 per cent confidence level.

In the case of transplanted pigeonpea growers, elasticity coefficient of seeds (0.013) was the significant at 1 per cent confidence level. Plant protection chemical (0.26) was found significant at 5 per cent level of confidence. Labour with (-0.11) was found to be non-significant. The regression coefficient of fertilizers is (0.28), which is contributing positively and found to be non-significant.

Table 4.9: Production function estimates in conventional and transplanted methods of pigeonpea cultivation

Sl. No.	Particulars	Parameter	Conventional	Transplanted	Pooled
1.	No. of observations	N	60	60	120
2.	Intercept	a	1.21 (0.713)	1.96 (1.23)	1.56 (2.21)
3.	Seed (Rs./ha)	X_1	-0.098*** (0.51)	0.013*** (0.0069)	-0.034*** (0.019)
4.	Fertilizers and manures (Rs./ha)	X_2	0.02*** (0.011)	0.28 (0.69)	0.147 (0.124)
5.	PPC (Rs./ha)	X_3	-0.034 ** (0.015)	0.26** (0.12)	-0.012** (0.56)
6.	Labour (Rs./ha)	X_5	0.035** (0.019)	-0.11 (0.019)	-0.034** (0.018)
7.	Dummy for Transplanted system	-	-	-	0.287** (0.137)
8.	Coefficient of multiple determination	R^2	0.72	0.69	0.67
9.	F Value	F	86.04	78.32	101.87

Note: *** Significant at 1% level
** Significant at 5% level
Figures in the parentheses indicate standard errors of coefficients

4.4.1 Marginal value product to marginal factor cost

The Cobb-Douglas function estimates and geometric levels of inputs were used to estimate the marginal value product. The knowledge of the marginal value products of resources facilitates comparison of marginal value product with marginal factor cost of the resources to arrive at optimal use of resources.

It was evident from the Table 4.10, that in the case of transplanted method the marginal value product to marginal factor cost ratio was found to be positive and more than unity for fertilizers and manures (8.50) and plant protection chemicals (5.72), indicating there is a scope for increasing the returns by increasing the use of resources. In the case of conventional method, the ratio of marginal value product to marginal factor cost were found to be negative and below unity for seeds (-9.39) and plant protection chemicals (-0.41),where as marginal value product to marginal factor cost ratios for fertilizers and manures (0.71) and labour (0.21) found positive but less than unity.

4.4.2 Geometric mean levels of returns and costs involved in transplanted and conventional systems

The per hectare geometric mean values of gross returns and input costs in transplanted and conventional systems were presented in Table 4.11

It was clear from the table that gross returns in transplanted system (Rs. 93485.85) were more than conventional system (Rs. 56382.30). Seed cost was 145.14 per cent higher in the case of transplanted system as it included the cost of polythene bags which are used for raising of seedlings. Other inputs like fertilizers and manures and labour were also higher in the case of transplanted system by 92.52 and 63.63 per cent, respectively. Plant protection chemicals cost was lower by 29.00 per cent in the case of transplanted system as compared to conventional system.

4.5 Decomposition analysis

4.5.1 Structural break in the production relation of transplanted and conventional pigeonpea production

In the case of pooled estimates with Dummy (Table 4.12) the explanatory power of variables included in the model were found to be 67.30 per cent, indicating that the model was a good fit. In this case, the value of intercept dummy was obtained as 0.28 at 5 per cent level of significance indicating that there was a structural break in production relation between conventional and transplanted system.

The total change in income received by pigeonpea growers due to adoption of transplanted system was decomposed using decomposition equation developed by Bisliah, provided in Chapter III. Using the production function estimates from Table 4.9 and geometric levels of returns and costs of inputs from Table 4.11. The results of output decomposition analysis were presented in Table 4.12

A perusal of the Table 4.12 revealed that the adopters of transplanted system of pigeonpea cultivation produced 65.57 per cent higher income than that of conventional system of pigeonpea. The increase in income was further decomposed into different sources of change such as adoption of transplanted system and all other inputs. The transplanted system alone contributed to 38.70 per cent increase in income, while the contribution of change in input levels was found to be positive (26.67%). Amongst various inputs, seeds (1.16%), fertilizers (18.34%), PPC (8.89%) contributed positively, whereas labour (-1.72%) contributed negatively to the gross income.

Table 4.10: MVP to MFC ratios of resources in pigeonpea cultivation

Explanatory variables	Parameters	Transplanted	Conventional
Seeds	b_1	0.84	-9.39
Fertilizer and manure	b_2	8.50	0.71
Plant protection chemicals	b_3	5.72	-0.41
Labour	b_4	-0.70	0.21

Table 4.11: Geometric mean levels of returns and cost involved in transplanted and conventional system

Sl. No.	Particulars	Transplanted	Conventional	Difference (%)
1	No. of observations	60	60	
2	Seed (Rs./ha)	1532.175	625	145.14
3	Fertilizers and manures (Rs./ha)	3020.3	1568.775	92.52
4	Plant protection chemicals (Rs./ha)	3302.5	4652.1	-29.00
5	Labour (Rs./ha)	14680	8970.925	63.63
6	Gross returns (Rs./ha)	93485.85	56382.3	65.57

Table 4.12: Estimated difference in income between transplanted and conventional system of pigeon pea cultivation

Technical Difference	
Total Observed Difference in Gross income	65.58
Due to Difference in Technology	38.70
1. Neutral Technological Difference	73.00
2. Non- Neutral Technological Difference	-34.29
Seeds	61.28
Fertilizers + manures	193.25
Plant protection chemicals	-170.15
Labour	-118.69
Due to Difference in Input Use Level	26.68
Seeds	1.16
Fertilizers + manures	18.34
Plant protection chemicals	8.89
Labour	-1.72
Total Estimated Difference in Gross income	65.38

4.6 Factors influencing in adoption of transplanted system of pigeonpea cultivation

The determinants of farmers' adoption of transplanted system of redgram were analyzed using logit model. The logit model and its principles were explanted in the section 3.4. The results of the analysis were presented in Table 4.13

The results indicated that the variables like education, income level, area under pigeonpea, irrigation availability, farmers extension contact and family labour availability were having significant positive influence on the adoption of transplanted system of pigeonpea. The odd's ratio is nothing but the coefficients of logit analysis. The respective marginal effect of above mentioned attributes on odd's ratio of probability of adoption of transplanted system were 0.154, 0.001, 0.031, 0.132, 0.305 and 0.013, respectively. The effect of age on the odd's ratio of probability of adopting transplanted system was negative (-0.08). From the analysis, it was observed that as the age of the farmer increases, the chances of adopting transplanted system i.e., modern technique is less and it was not statistically significant. The log likely hood value was found to be 39.56

4.7 Problems of pigeonpea growers

An informal discussion with the pigeonpea growers revealed that pigeonpea production involved many problems. Opinion survey was conducted to know the Bio-physical, socio-economic and other problems faced by the pigeonpea growers. Results have been presented in Table 4.14

4.7.1 Transplanted method

The problems faced by the growers have been presented under the following headings

4.7.1.1 Bio-Physical Problems

From the results presented in Table 4.14, it was revealed that,. Higher incidence of pests and diseases (81.66 percent), Lack of storage facilities (75.00 per cent), damage of pods due to bending of the side branches (71.66 per cent), non-availability of water for irrigation (33.00 per cent), non-availability of suitable high yielding varieties (21.00 per cent), and low yield per hectare (6.60 per cent) were the other important Bio-physical problems expressed by transplanted method of pigeon pea cultivating farmers.

4.7.1.2 Socio-Economic Problems

Results presented in the table 4.14, revealed that 95.00 per cent of the farmers expressed fluctuations in the prices of commodity as the major socio-economic problem. Costly plant protection chemicals (76.66 per cent), absence of higher price in the local markets (73.33 per cent), delay in getting credit (51.66 per cent), high commission charges (36.66 per cent), more burden of repayment (26.66 per cent), high rate of interest (25.00 per cent), insurance coverage problem (23.33 per cent), non-availability of credit (15.10 per cent) were the other socio-economic problems.

4.7.1.3 Other Problems

From the results presented in Table 4.14, it was revealed that, about 86.66 per cent of the farmers expressed high labour requirement as the major other problem expressed by the sample farmers. Non-availability of required labour (73. per cent), rigid security requirement (45.00 per cent), non-availability of market related information (28.33 per cent), faulty weighment (13.33 per cent), non-availability of information on improved technologies (8.30 per cent), inaccurate weighing instruments (6.66 per cent) were the other problems expressed by the sample farmers).

Table 4.13: Factors influencing the adoption of transplanted method of pigeonpea

Sl. No.	Independent variables	Logit coefficient	Standard error
1.	Intercept	-16.36*	5.62
2.	Age (years)	-0.08	0.059
3.	Education (years)	0.154*	0.024
4.	Income level (Rs)	0.001***	0.00056
5.	Area under pigeon pea (hectares)	0.031**	0.0131
6.	Irrigation availability (yes/no)	0.132**	0.0560
7.	Extension contact (yes/no)	0.305*	0.0388
8.	Family labour availability (no.)	0.013**	0.00530
	R^2	0.87	
	F Value	115.83	
	-2 log likelihood value	39.561	

Note: *** Significant at 1% level
** Significant at 5% level
* Significant at 10% level

Table 4.14: Problems of pigeonpea growers (opinion survey)

Sl. No.	Problems	Transplanted (n=60)		Conventional (n=60)	
		Freque-ncy	Perce-ntage	Freque-ncy	Perce-ntage
A	**Bio-physical problems**				
1.	Non-availability of short duration HYV's	13	21.66	19	31.66
2.	Non-availability of water for irrigation	20	33.33	31	51.66
3.	Higher incidence of pests and diseases	49	81.66	57	95.00
4.	Lack of storage facilities	45	75.00	53	88.33
5.	Lower yield per hectare	4	6.60	42	70.00
6.	Damage of pods due to bending of branches	43	71.66	0	0.00
B	**Socio-economic problems**				
1.	Costly plant protection chemicals (PPC)	46	76.66	47	78.33
2.	Fluctuation in the prices of commodity	57	95.00	58	98.66
3.	High commission charges	22	36.66	23	38.33
4.	Absence of higher price in the local markets	44	73.33	41	68.33
5.	Non-availability of credit	9	15.10	8	13.33
6.	Delay in getting credit	31	51.66	26	43.33
7.	High rate of interest	15	25.00	13	21.66
8.	More burden of repayment	16	26.66	32	53.33
9.	Insurance coverage problems	14	23.33	12	20.00
C	**Other problems**				
1.	Non- availability of required labour	44	73.00	45	75.00
2.	Non-availability of information on improved technologies	5	8.30	31	51.66
3.	High labour requirement	52	86.66	0	0.00
4.	Non-availability of market related information	17	28.33	24	40.00
5.	Faulty weighment	8	13.33	10	16.66
6.	Inaccurate weighing instruments	4	6.66	6	10.00
7.	Rigid security requirement	27	45.00	21	35.00

4.7.2 Conventional method

4.7.2.1 Bio-Physical problems

From the Table 4.14, it was revealed that, high incidence of pests and disease was the major Bio-physical problem expressed by the (95.00 per cent) sample farmers. Lack of storage facilities (88.33 per cent), lower yield per hectare (70.00 per cent), non-availability of water for irrigation (51.66 per cent), and non-availability of suitable high yielding varieties (31.66 per cent) were the other problems expressed by the sample farmers.

4.7.2.2 Socio-economic problems

Results obtained from the Table 4.14, revealed that 98.66 per cent of the farmers expressed fluctuations in the prices of commodity as the major socio-economic problem.. Costly plant protection chemicals (78.33 per cent), absence of higher price in the local markets (68.33 per cent), more burden of repayment (53.33 per cent), delay in getting credit (43.33 per cent), high commission charges (38.33 per cent), high rate of interest (21.66 per cent), insurance coverage problem (20.00 per cent), non-availability of credit (13.33 per cent) were the other problems expressed by the sample farmers.

4.7.2.3 Other problems

Results revealed that non-availability of required labour (75.00 per cent) was the major problem faced by the sample farmers. Non-availability of information on improved technologies (51.66 per cent) non-availability of market related information (40.00 per cent), rigid security requirement (35.00 per cent), faulty weighment (16.66 per cent), inaccurate weighing instruments were the other problems expressed by the sample farmers.

5. DISCUSSION

The results of the investigation presented in the preceding chapters are discussed in detail in this chapter. The discussion throw light on the possible causes for the results obtained and are presented under the following heads.

5.1 General characters of the sample farmers in the study area

5.2 Cost incurred in cultivation of pigeonpea in transplanted and conventional system

5.3 Returns in transplanted and conventional system of pigeonpea cultivation

5.4 Resource use efficiency in the case of transplanted and conventional system of pigeonpea production

5.5 Decomposition analysis

5.6 Factors influencing in adoption of transplanted system of pigeonpea cultivation

5.7 Problems of pigeonpea growers

5.1 General characteristics

The general characteristics of the respondents are presented in Table 4.1. Transplanted pigeonpea growers were younger compared to farmers following conventional method of pigeonpea cultivation. Agriculture was the major occupation in both the cases. Transplanted pigeonpea farmers were more literate as compared to growers of pigeonpea under conventional system. Average family size in transplanted farmers was about seven members, wherein in the case of conventional farmers, it was six members. Average land holding in the case of transplanted farmers was 8.17 hectares, in which 4.76 hectares dry and rest was found to be irrigated (3.41 hectares). Borewells and open wells were the major sources of irrigation in both the cases. Conventional pigeonpea farmers had an average land holding of 6.56 hectares, in which 4.96 hectares was dry and remaining 1.60 hectares was irrigated. From the results, it was revealed that the farmers who had switched over to transplanted method of pigeonpea were younger farmers who are innovative in nature. Moreover they were literate and thus able to understand the technology and the likely benefits of this method. In addition, the size of land holding was also more and the proportion of irrigated land was also of higher magnitude. All these factors made them to go for transplanted method of pigeonpea cultivation.

5.1.1 Cropping pattern of sample farmers

The absolute area devoted to different crops by transplanted and conventional system of pigeonpea (cultivation) growers pertaining to agricultural year 2010-11 is presented and results are mentioned in Table 4.2

In *kharif* season, pigeonpea was the major crop in both transplanted and conventional system, because of the suitable agro-climatic condition, low water requirement of the crop along with good returns. Hence, major area in both cases was occupied by pigeonpea. Greengram, blackgram, sunflower were the other crops cultivated by transplanted and conventional method of pigeonpea cultivating farmers during *kharif*.

In *rabi* season, jowar was the main crop in both systems as it was the staple food of the Northern Karnataka region. Wheat cultivated on farms having irrigation facilities in both transplanted and conventional system of pigeonpea cultivation. Chickpea and groundnut were the other crops grown during *rabi* season in the case of conventional pigeonpea growers. In summer, farmers having irrigation facilities cultivated vegetables. Horticultural crop like banana is grown in small area, in the case of transplanted pigeonpea cultivation farmers. From the foregoing discussion it was clear that those farmers who had a higher size of holding with irrigation facilities were able to devote higher area under pigeonpea and also taking up crops like banana and vegetables. The farmers were also having more resource endowments for taking up of innovative ideas.

5.1.2 Input use pattern in transplanted and conventional methods of pigeonpea cultivation

5.1.2.1 Input use pattern in transplanted method

From the results presented in Table 4.3, it was revealed that seed, farm yard manure, chemical fertilizers, polythene bags and plant protection chemicals were the inputs used by the transplanted method of pigeon pea cultivating farmers.

In transplanted method of pigeonpea cultivation, seedlings were raised by using an average of 4.60 kg per ha of seeds, which was nearly three times less than the seeds used in conventional method. Plant population was the main reason for such a low seed utilization in transplanted method. In conventional method, plant population was more than a lakh for one hectare, where in transplanted method the plant population was nearly 7500 for one hectare area. This was the main reason for yield difference in these two methods.

Farm yard manure was used in transplanted method of pigeonpea cultivation at the rate of 10 quintals per ha of FYM was used for preparation of seedlings for one hectare area. It indicates that the FYM requirement in transplanted method was less, as the plant population was very less compared to conventional method where plant population maintained was found to be more than a lakh per hectare. Due to large quantity requirement and non-availability, the use of FYM was not there in the case of conventional method.

A total of 11.25 kg of polythene bags were used in transplanted method towards raising seedlings in one hectare. In the case of conventional method, there was no requirement of these polythene bags as they were going for drill sowing. The total amount of plant protection chemicals used by transplanted method of pigeonpea cultivating farmers was marginally less as compared to conventional method. In transplanted method, crop will escape the attack of pod borer due to early sowing which was the major pest of pigeonpea. Hence, the total amount of pesticides use was less in transplanted method.

5.1.2.2 Input use pattern in conventional method

From the results presented in Table 4.4 ,it was revealed that, a total of 12.25 kg seeds per ha were used by the farmers, which was more than 3 times that of transplanted method as they are going for drill sowing which requires higher seed rate as compared to transplanting method. In the case of fertilizers, 43.70 kg per ha of nitrogen and 52.90 kg per ha of phosphorous were used by farmers, which was less compared to transplanted method. In the case of transplanted method, the increased use of fertilizers contributing positively towards the gross returns. In this method also fertilizers contributing positively towards gross returns, but not to the extent of transplanted method. Chemical pesticides worth of Rs.4668.75 were used towards the plant protection measures.

5.1.3 Labour use pattern in transplanted and conventional methods of pigeonpea cultivation

5.1.3.1 Labour use pattern in transplanted method

Labour requirement for each operation in the case of transplanted method of pigeonpea cultivation for an area of one hectare were shown in the Table 4.5

In transplanted method, totally 87.90 man days of human labour, 18.55 pair days of bullock labour and 3.56 hours of machine labour were employed. Human labour requirement was higher in the case of transplanted method as compared to conventional method of pigeonpea cultivation, as it involves raising of seedlings and transplanting them into the main field. Hence, human labour requirement was more in this method.

The overall bullock labour requirement in transplanted method was marginally less when compared to conventional method, as bullock labour was used for drill sowing, which was absent in transplanting method, where seedlings were prepared and transplanted into main field with the help of human labour.

Total machine labour utilized was found to be lower in the case of transplanted method as compared to conventional method. This difference was due to the use of machine labour for sowing by some of the sample farmers, which was absent in the case of transplanted method of pigeonpea cultivation.

5.1.3.2 Labour use pattern in conventional method

In the case of conventional method a total of 45.36 man days of human labour, 19.53 pair days of bullock labour and 5.35 hours of machine labour were utilized. Labour requirement for each operation in the case of transplanted method of pigeonpea cultivation for an area of one hectare were shown in the Table 4.6

Human labour requirement in this method was low when compared to transplanted method, where human labour requirement towards raising of seedlings, transplanting them into main field, clipping, transportation and spreading of FYM were the additional operations which needs more of human labour.

With respect to the bullock labour use pattern, it was seen that the use of bullock labour was found to be almost same in both the methods. The marginal difference in the use of bullock labour between these two methods was attributed to the sowing operation, which was absent in transplanted method. The machine labour use was higher in conventional method, as some of the sample farmers using machine labour for sowing operations due to inadequacy of human and bullock labour in the study area.

5.2 Cost incurred in cultivation of pigeonpea in transplanted and conventional methods

From the results presented in Table 4.7, it was evident that per hectare cost of cultivation of pigeonpea was more in the case of transplanted system as compared to conventional method *i.e.*, Rs. 39382.28 and Rs. 30819.53, respectively. This difference in cost was attributed to the higher cost of human labour, polythene bags for raising seedlings, seed treatment chemicals and manures.

The per hectare variable cost (Rs.25892.65) was more in transplanted system and it is due to additional items like seed treatment chemicals and polythene bags *i.e.*, Rs. 199.15 and Rs.1064.37. Human labour cost was the highest share *i.e.,* Rs. 9588.75 compared to conventional system *i.e.*, Rs. 3762.50 only in the case of conventional system. The variable cost in the case of conventional system was Rs. 17527.63. The higher human labour cost in case of transplanted system was because of the high labour requirement for raising seedlings and transplanting into the main field. The farmers who had adopted transplanted method were spent about 47 per cent more cost due to the additional interventions required for this method.

In the case of conventional, the cost incurred on plant protection chemical and seeds were more when compared to transplanted system. It was because of over usage as against the recommended package of practices. Fertilizer and manures cost was more in the case of transplanted system, as it includes the manures, which was used along with fertilizers while preparing/raising seedlings, which was not used by the conventional farmers. The cost incurred on bullock labour was high in the case of transplanted system, because of additional intercultivation operations to remove weeds, because of wider spacing involved in the transplanted system.

The per hectare fixed costs were marginally (1.48 per cent) higher in transplanted system (Rs.13489.28) when compared to conventional system (Rs.13291.88). The cost incurred on land revenue and land rents were similar in both transplanted and conventional system of pigeonpea cultivation. Overall, the total cost was higher in the case of transplanted method of pigeonpea cultivation over conventional method to the extent of 27.78 per cent.

Similar results were obtained by Radha and Choudhary (2005), in their study on cost of commercial production and seed production of cotton in Karnool district of Andhra Pradesh. Rajeshwari (2004) found similar results in cost and returns of coconut based farming systems in Tumkur district of Karnataka.

5.3 Returns in transplanted and conventional system of pigeonpea cultivation

From the Table 4.8, it was evident that per hectare average yield in transplanted (26.25 qtls) was higher when compared to conventional system (15.25 qtls). Yield was more in transplanted system as growers were planting seedlings, which can tolerate adverse weather conditions having drought resistance, higher branching and higher pods per plant.

Even when the onset of monsoon was late, the farmers can prepare seedlings and directly transplanted in the main field. In the case of conventional method the farmers may not go for sowing if the monsoon gets delayed or they may get lower yield due to delayed monsoon.

Market price per quintal of pigeonpea was slightly higher in the case of conventional as compared to transplanted. It was mainly due to the average of the prices received by the farmers. The per hectare marketing cost was higher in transplanted system. It was due to higher transportation cost, since the fields of the growers have been located at a far off distance and the quantity transported was also of higher magnitude as the yield was higher in the case of transplanted system.

Gross returns were higher in transplanted system as compared to conventional system, which was mainly due to higher productivity in transplanted system of pigeonpea cultivation. Similarly, net returns in transplanted system was more than that of conventional system *i.e.*, Rs. 54103.25 and Rs. 25562.78, respectively. The returns to cost ratio was higher in transplanted system of pigeonpea (2.37) as compared to conventional system (1.82). Hence, transplanted system of pigeonpea cultivation was more profitable as compared to conventional method of pigeonpea cultivation.

Similar results were observed by Biradar (2007) in his study on economics of redgram based cropping systems in Bidar district. Suckpal Singh *et al.* (2005) found similar results in their study in IPM and IRM technology. Gadere and Malale (1988) obtained similar results in their study from cotton crop in Vidharbha region of Maharashtra.

5.4 Resource use efficiency in the case of transplanted and conventional method of pigeonpea production

The estimates of production functions for conventional and transplanted method of pigeonpea production are presented in Table 4.9

Perusal of the table reveals that in the case of conventional system, every one per cent increase in the expenditure of variables seeds and plant protection chemicals over and above geometric mean levels would decrease the gross returns by 0.098, 0.034 respectively. The elasticities of seeds and plant protection chemicals were negative and significant suggesting that an increase in the case of these factors over and above the present value resulted in substantial decrease in output of conventional pigeonpea farmers.

In the case of transplanted system of pigeonpea, additional one rupee spent on variables seeds, fertilizer and manures and plant protection chemicals were found to increase the gross returns per rupee (0.013 and 0.28 and 0.26 respectively). But in the case of labour, every 1 per cent increase in the expenditure was found to decrease the gross returns by 0.11.In the case of pooled estimate with intercept dummy for transplanted and conventional systems it was found that the variables of seed and plant protection chemicals were decreasing the gross returns by Rs. 0.034 and 0.012, respectively. Unit rupee increase in case of fertilizer was found to increase the gross returns by 0.147, but the result was not found to be statistically valid. Similar results to that of conventional and transplanted system were obtained in the case of pooled labour estimate. Additional one rupee spent on labour was found to decrease the gross returns by Rs. 0.034.

The coefficients of determination in the case of conventional and transplanted system were 0.72 and 0.69, respectively indicating that the model was a good fit.

This reveals that the independent variables included in the model have explained 72 and 69 per cent of the variation in the dependent variables of conventional and transplanted methods, respectively.

In the case of pooled estimates with dummy, the explanatory power of variables increased in the model was found to be 67 per cent indicating that the model was a good fit. In this case, the value of intercept dummy was obtained as 0.287 at 5 per cent level of significance, indicating that there was structural break in production relation between conventional and transplanted system.

This implied that the parameter generating the input-output relations in the case of conventional farmers was different from those of transplanted farmers.

Similar results were obtained by Saikumar (2005) in his study on resource use efficiency in different farming systems in Bidar, Bellary and Raichur districts of north-eastern Karnataka. Verma (2002) found similar results in his resource use efficiency study in onion crop.

5.4.1 Marginal value product to marginal factor cost

In the case of transplanted method, the ratio of the marginal value product to marginal factor cost were presented in Table 4.10. The table revealed that the allocative efficiency was positive and greater than unity for fertilizers and manures and plant protection chemicals, indicating that, there is still scope for use these inputs and increase the gross returns. In the case of conventional method, the ratio of the marginal value product to marginal factor cost reveals that, allocative efficiency for fertilizer and labour were found to be positive and less than unity, where as allocative efficiency of seeds and plant protection chemicals were found negative and less than unity. Overall all the inputs were over utilized and increased use of these will contribute negatively towards the gross returns.

5.4.2 Geometric mean levels of returns and costs involved in transplanted and conventional systems

The per hectare geometric mean levels of gross returns and input costs in the transplanted and conventional methods of pigeonpea cultivation were presented in Table 4.11. From the results, it was revealed that per hectare average gross returns were more in transplanted system when compared to conventional system. It was mainly due to the higher yield obtained in transplanted system. The cost of seeds was higher in case of transplanted system, as it also includes polythene bag costs, which are used for raising seedlings. Fertilizer and manures cost was more in transplanted method as compared to conventional method, which excluded use of manures while raising seedlings. The cost of plant protection chemical was comparatively less in transplanted method as compared to conventional method, as one or two sprays were used in transplanted method, as it escapes the pod borer damage due to early sowing. Labour cost was higher in transplanted system as the labour requirement for raising seedlings and transplanting into the main field was more, while it was not there in conventional system.

5.5 Decomposition analysis

On examining the results of decomposition of the difference in gross income between transplanted and conventional method of pigeonpea cultivation, it could be observed that the total estimated difference in gross income between the technology was 65.57 per cent. Of which 38.70 per cent was attributed purely due to difference in technology and 26.67 per cent due to difference in input use level for the two technologies. This suggested that the present level of input application was done to conventional system; yield could be increased by 38.70 per cent just by switching over from conventional system to transplanted system. This means that with no further input application, the yield could be raised by 38.70 per cent just by adoption of modern technology. Such an improvement in yield performance could have been brought by change in scale and/or slope parameters, which referred to as neutral /non-neutral technological change.

If the farmer could simultaneously increase the input application along the adoption of transplanted system, the yield could have been increased by an additional amount of 26.67 per cent thus raising the total gross income differential to 65.57 per cent.

Out of the total difference in technology (38.70), 73.00 per cent was contributed by neutral technology alone, whereas the contribution of non-neutral technological difference was -34.29 per cent, this indicates that technological change was mainly neutral type. The high positive neutral technological component signifies that with the present level of input application has been done in conventional system, farmers could have increased the gross income by 73.00 per cent, provided efficiency in input application associated with the new technology had constant or in other words, it could be put that the contribution of neutral technological change was moved downwards by failure on the part of farmers or the agricultural system to improve the efficiency in input application as was warranted for transplanted system. Thus, the net efficiency in input application reduced the possible technological difference by 34.29 per cent.

It could also be observed that the highest insufficiency of the zone was associated with the plant protection chemicals (-170.15%) followed by labour (-118.68%). Seed and fertilizer contributed positively. This indicated that, increased efficiencies of seeds and fertilizers, together raised the productivity by 254.53 per cent, the net non-neutral technological difference was one of the negative order (-34.29%), due to decrease in use efficiency of high magnitude (288.83%), brought about by plant protection chemicals and labour. Thus, while shifting from conventional to transplanted system had the efficiency of plant protection chemicals and labour, increased or remained constant, there would have been an increase in the gross income of transplanting technology resulting in the increased gross income gap.

The total contribution of difference in the levels of input use to the gross income, gap accounted to 26.67 per cent, this indicated that gross income of the conventional system could be increased by 26.67 per cent, if the per acre input use level could be increased to the same level as of the transplanted farmers.

While interpreting the results in input use level it is to be taken care of that the negative sign of the variables associated with the reduction in labour and hence increased use of labour would have contributed positively towards gross income increment of the transplanted system.

Similar results were obtained by Gaddi *et al* (2002) by using output decomposition model in cotton.

5.6 Factors influencing the adoption of transplanted method of pigeonpea cultivation

The determinants of farmers' opinion in adoption of transplanted system of pigeonpea were analyzed using logit model. Results of analysis were presented in Table 4.13. Though not statistically significant, the variable age was found to increase the adoption behavior in negative manner. This mainly because, as aged farmer will be reluctant in adopting modern technologies, whereas chance of young farmers adopting improved technology was more.

The impacts of extension contact and education level were as expected as these two variables give thrust for adoption of modern technologies.

The variable income level was found to have positive influence on adoption of transplanted system. It can be attributed to the farmers that the transplanted system of pigeonpea involves more cost when compared to conventional system. Hence, resourceful farmers have more chance of adopting transplanted system.

The area under pigeonpea was found to have positive influence on the adoption of transplanted system. Farmers having more area under pigeonpea were likely to adopt transplanted system as the chance of experimentation with new technology was more in their case.

Transplanted system of pigeonpea involves raising of nursery with high water requirement. Hence, availability of irrigation facilities increases the probability of the adoption of transplanted system.

Family labour availability have a positive influence on adoption of transplanted system of pigeonpea and it can be correlated to the fact that raising seedlings, which can be done by family labour. As the family labour availability increases ,the adoption of transplanted system increases.

The log likelihood estimate was observed to be 39.56. The reliability of the result as indicated by the negative log-likelihood ratio was found to be satisfactory.

Similar results were obtained by Ramesh and Govind (2001) in their study on organic farming practices in paddy in Pudukatti district of Tamil Nadu.

5.7 Problems of pigeonpea growers

An informal discussion with the pigeonpea growers revealed that pigeonpea cultivation has lot of problems. These problems are divided into Bio-physical, socio-economic and other problems and they are presented in Table 4.14.

5.7.1 Transplanted method

5.7.1.1 Bio-Physical problems

It was revealed that majority of the sample farmers opined that Pod borer was the major pest of pigeonpea and control / maintenance of that requires many sprays of different pesticides, which were very costly. Due to vigorous growth of individual plant in transplanting method, bending of the side branches was observed. The branches which were bent will come into contact with the soil surface, which in turn damage the pods, thus reducing the yield.

Lack of irrigation projects in the scanty area reduced the availability of water for irrigation. Non-availability of suitable high yielding varieties and lower yield per hectare due to low fertility of the soils in the study area was also a problem expressed by the sample farmers.

5.7.1.2 Socio-economic problems

Majority of the farmers expressed fluctuation in the prices of the commodity as the major socio-economic problem. Crop requires many chemical sprays to control pest and disease which are very costly. Absence of higher price in the local markets, delay in getting credit due to lengthy procedures involved in the sanction of financial assistance, high commission charges, were the other problems expressed by the farmers. More burden of repayment problem is mainly because of uncertainty in the income of the sample farmers. High rate of interest by money lenders and non-availability of credit were also the other socio-economic problems. Farmers who get financial assistance from co-operative banks and commercial banks will be naturally covered under insurance, where as farmers who took the financial assistance from the money lenders were devoid of the insurance coverage.

5.7.1.3 Other problems

Majority of the sample farmers expressed high labour requirement was the major problem in transplanted method, as it involves raising of seedlings and transplanting them into main field, which needs more of human labour. Non-availability of required labour during peak period was caused by migration of agricultural work force from the study area. Rigid security requirement to avail the financial assistance was also a problem faced by the sample farmers. Non-availability of market related information, non-availability of information on improved technologies, faulty weighment and inaccurate weighing instruments were the other problems of the sample farmers. These problems might be due to the malpractices carried out by the traders who were involved in the procurement of pigeonpea.

5.7.2 Conventional method

5.7.2.1 Bio-Physical problems

From the results obtained in the Table 4.14, it was revealed that higher incidence of pests and disease was also a major problem in the production of pigeonpea in the case of conventional method. As compared to transplanted method, the number of sprays of pesticides was more in conventional method, due to higher incidence of pod borer, which was the major pest, where in transplanted method; the pigeonpea crop will escape the attack of pod borer due to early sowing. Lower yield per hectare was due to low fertility of the soils the study area. Lack of irrigation projects in the study area had lead to non-availability of water for irrigation. Non-availability of suitable high yielding varieties was one more Bio-Physical problem

5.7.2.2 Socio-economic problems

Majority of the conventional method of pigeonpea cultivating farmers expressed that fluctuation in the prices of the commodity, as the major socio-economic problem. In this method also majority of the farmers felt that plant protection chemicals were costly. Absence of higher price in the local markets, more burden of repayment, this might be due to the uncertainty of the income of the sample farmers. Delay in getting credit due to lengthy procedures involved in the sanction of financial assistance. High commission charges, high rate of interest by money lenders were the other problems.

Farmers who took financial assistance from co-operative and commercial banks were covered under insurance, where as farmers availing the financial assistance from money lenders were not come under insurance coverage. Non-availability of credit was also a problem expressed by some of the sample farmers.

5.7.2.3 Other problems

Migration of the agricultural work force from the study area had lead to non-availability of labour during peak season in the study area. Non-availability of the information on improved technology, non-availability of market related information may be due to the low education level of the sample farmers. Rigid security requirement by financial institutions to avoid the mis use of the credit advanced. Faulty weighment and inaccurate weighing instruments were the other problems expressed by the sample. These problems might be due to the malpractices carried out by the traders who were involved in the procurement of pigeon pea

Similar results were observed by Ramrao and Ray (1985) in their study on identification of constraints in pulse production in the states like Bihar, Madhya Pradesh, Maharashtra, Orissa, Rajasthan and Uttar Pradesh. Naik (1998) in his study on economics of farming systems in Uttara Kannada district, identified similar production, marketing and financial problems.

6. SUMMARY AND POLICY IMPLICATIONS

Agriculture is one of the most important activities in both developed and developing countries which provide food stuff to human beings and raw materials to man and various agro- based industries. It continues to be the main stay of Indian economy and an effective antidote to poverty and unemployment. Indian rural economy is basically considered to be a crop economy. In India agriculture and other allied activities contribute significantly to the Gross Domestic Product (GDP), accounting nearly 16 per cent of the total GDP. It provides employment to around 64 per cent of the work force while contributing18 per cent of the total exports. India with only 2.3 per cent of world's total land area supports eighteen per cent of human and fifteen per cent of live stock population in the world.

Pulses play an important role in Indian agricultural economy as they are rich sources of proteins and constitute ten to fifteen per cent of India's food grain diet. India is the largest producer and consumer of pulses in the world accounting for 33 per cent of the world area and 27 per cent of the world production of pulses. India is the largest producer of red gram accounting 90 per cent of total production and 80 per cent of total area of the world. In India, pulses are grown on 23 million hectares area with a production of 15 million tones, with a per hectare yield of 600 kg.

In Karnataka pigeon pea is largely grown in northern parts, especially in Gulbarga and Bidar districts. The state occupies an area of about 5.96 lakh hectares with a production of 3.15 lakh tonnes, having an average productivity of 556 kg/ha. Gulbarga is known as "pigeon pea bowl of Karnataka". Gulbarga has an area of about 3.79 lakh hectares with production of 1.94 lakh tonnes and a productivity of 539 kg/hectare. Bidar with an area of 62,667 hectares, production of 50,127 tonnes with a productivity of 842 kg/hectares stands second, while Bijapur having an area of 48,686 hectares and production of 19,472 tonnes with average productivity of 421 kg/hectare holds third position.

Transplanting method of pigeon pea cultivation is one of the recent developments in pigeon pea cultivation and gaining importance in pigeon pea growing farming community. It improves both production and productivity. It is recommended for successful and profitable cultivation of red gram. In this method pigeon pea seedlings are raised in nursery,seedlings will be ready in about 30-40 days and then transplanted into the main field. It yields about 12-14 qtls/acre in rain fed conditions and about 16-18 qtls/acre in irrigated conditions. Now it is cultivated mainly in Gulbarga and Bidar districts and in the days to come it may occupy larger pigeon pea cultivated area in the state especially in northern parts of Karnataka. During 2009-10, about 4000 hectares of area was under transplanted pigeon pea (KVK.Bidar). Hence the present study is proposed to know the different dimensions of pigeonpea cultivation in the changed scenario with the following objectives.

1. To work out cost and returns in transplanted and conventional method of pigeon pea cultivation.
2. To analyse the resource use efficiency under the two methods.
3. To study the factors influencing in adoption of transplanted method of pigeon pea cultivation.
4. To document problems faced by growers of pigeon pea.

Study region and sampling

Pigeon pea cultivation is mainly concentrated in northern parts of Karnataka especially in Bidar and Gulbarga districts. Transplanted method of Pigeon pea cultivation is also mainly practiced in these two districts. Hence, the study has been conducted in Bidar and Gulbarga districts which come under zone-1 and zone -2 regions respectively in Karnataka state. A total of 120 sample farmers were selected randomly for the study which comprises 60 transplanting method producers of pigeon pea and 60 traditional methods of pigeon pea producers in Bidar and Gulbarga districts.

Analytical tools employed

1. Tabular analysis
2. Cobb-Douglas production function
3. Logit model.
4. Decomposition model

Findings of the study

Cost involved in cultivation of pigeonpea in transplanted and conventional system

The total cost of cultivation in transplanted system was found to be higher than that of conventional system. The average cost of cultivation in the case of transplanted system of pigeonpea was Rs. 39382.28 as against Rs. 30819.53 in conventional system of pigeonpea. The cost of fertilizers and manures, human labour, seed treatment were the differing factors in the cost in the case of transplanted system of pigeonpea pea cultivation.

The proportion of variable cost was Rs. 25892.65 and Rs. 17527.63 accounting for 65.74 and 56.87 per cent in the case of transplanted and conventional system of pigeonpea cultivation, respectively. The share of fixed cost in total cost of cultivation in the case of transplanted pigeonpea growers was 34.25 per cent (Rs. 13489.63) and in the case of conventional pigeonpea growers 43.12 per cent (Rs. 13291.88). Among the items of fixed cost, the rental value of the land had a maximum share in the total cost of cultivation in both transplanted and conventional farmers.

Returns in transplanted and conventional method of pigeonpea cultivation

The per hectare average yield of pigeonpea on transplanted farm (26.25 qtls) was higher than that of conventional system of pigeonpea growers (15.25). The average market price in transplanted was slightly lower (3600/qtl) than that of conventional system. Total marketing cost cost per hectare in transplanted pigeonpea growers was Rs. 1706.25 as against Rs. 915.00 in the case of conventional pigeonpea growers.

The returns structure in transplanted pigeonpea growers revealed that gross returns per hectare was higher i.e Rs. 93485.85 as against Rs. 56382.30 in the case of conventional pigeonpea growers. The net returns on both systems were found to be positive *i.e.*, Rs. 54103.25 and Rs. 25562.78 in transplanted and conventional system, respectively. Though, the per quintal price in transplanted was lower, the net returns were higher than conventional system because of higher yields. The returns to cost ratio was higher in the case of transplanted (2.37) compared to conventional system of pigeonpea growers (1.82).

Resource use efficiency in the case of transplanted and conventional method of pigeonpea production

In the case of conventional pigeonpea growers, the regression coefficient for seeds and plant protection chemicals were negative (-0.098 and -0.034) and significant at 1 and 5 per cent confidence level respectively. Whereas, fertilizers and manures (0.02) was positive and significant at 1 per cent confidence level, labour (0.035) was positive and found to be significant at 5 per cent confidence level.

In the case of transplanted pigeonpea growers, regression coefficient of seeds (0.013) was significant at 1 per cent confidence level. Plant protection chemical (0.26) was found significant at 5 per cent level of confidence. Labour with (-0.11) was found to be non-significant. The regression coefficient of fertilizers is (0.28), which is contributing positively and found to be non-significant.

The coefficient of multiple determination (R^2) was 0.72 and 0.69 for conventional and transplanted system of pigeonpea growers, respectively.

Marginal value product to marginal factor cost

In the case of transplanted method the marginal value product to marginal factor cost ratio was found to be positive and more than unity for fertilizers and manures (8.50) and plant protection chemicals (5.72), indicating there is a scope for increasing the returns by increasing the use of resources. In the case of conventional method, the ratio of marginal value product to marginal factor cost were found to be negative and below unity for seeds (-9.39) and plant protection chemicals (-0.41), where as marginal value product to marginal factor cost ratios for fertilizers and manures (0.71) and labour (0.21) was positive but less than unity.

Geometric mean levels of returns and costs involved in transplanted and conventional systems

The per hectare geometric mean values of gross returns and input costs in transplanted and conventional systems were presented in Table 4.11

It was clear from the table that gross returns in transplanted system (Rs.93485.85) were more than conventional system (Rs. 56382.30). Seed cost was 145.14 per cent higher in the case of transplanted system. Other inputs like fertilizers and manures and labour were also higher in the case of transplanted system by 92.52 and 63.63 per cent, respectively. Plant protection chemicals cost was lower by 29.00 per cent in the case of transplanted system as compared to conventional system.

Decomposition analysis

Structural break in the production relation of transplanted and conventional pigeonpea production

In the case of pooled estimates with Dummy (Table 4.9) the explanatory power of variables included in the model were found to be 67.30 per cent, indicating that the model was a good fit. In this case, the value of intercept dummy was obtained as 0.28 at 5 per cent level of significance indicating that there was a structural break in production relation between conventional and transplanted system.

The results revealed that the adopters of transplanted system of pigeonpea cultivation produced 65.57 per cent higher income than that of conventional system of pigeonpea. The increase in income was further decomposed into different sources of change such as adoption of transplanted system and all other inputs. The transplanted system alone contributed to 38.70 per cent increase in income, while the contribution of change in input levels was found to be positive (26.67%). Amongst various inputs, seeds (1.16%), fertilizers (18.34%), PPC (8.89%) contributed positively, whereas labour (-1.72%) contributed negatively to the gross income.

Factors influencing in adoption of transplanted system of pigeonpea cultivation

The determinants of farmers' adoption of transplanted system of redgram were analyzed using logit model. The results indicated that the variables like education, income level, area under pigeonpea, irrigation availability, farmers extension contact and family labour availability were having significant positive influence on the adoption of transplanted system of pigeonpea. The odd's ratio is nothing but the coefficients of logit analysis. The respective marginal effect of above mentioned attributes on odd's ratio of probability of adoption of transplanted system were 0.154, 0.001, 0.031, 0.132, 0.305 and 0.013, respectively. The effect of age on the odd's ratio of probability of adopting transplanted system was negative (-0.08), it was not statistically significant. The log likely hood value was found to be 39.56.

Problems of pigeonpea growers

Transplanted method

Bio-Physical Problems

From the results presented in Table 4.14, it was revealed that,. Higher incidence of pests and diseases (81.66 percent), Lack of storage facilities (75.00 per cent), damage of pods due to bending of the side branches (71.66 per cent), non-availability of water for irrigation (33.00 per cent), non-availability of suitable high yielding varieties (21.00 per cent), and low yield per hectare (6.60 per cent) were the other important Bio-physical problems expressed by transplanted method of pigeon pea cultivating farmers.

Socio-Economic Problems

Results presented in the table 4.14, revealed that 95.00 per cent of the farmers expressed fluctuations in the prices of commodity as the major socio-economic problem. Costly plant protection chemicals (76.66 per cent), absence of higher price in the local markets (73.33 per cent), delay in getting credit (51.66 per cent), high commission charges (36.66 per cent), more burden of repayment (26.66 per cent), high rate of interest (25.00 per cent), insurance coverage problem (23.33 per cent), non-availability of credit (15.10 per cent) were the other socio-economic problems.

Other Problems

From the results presented in Table 4.14, it was revealed that, about 86.66 per cent of the farmers expressed high labour requirement as the major other problem expressed by the sample farmers. Non-availability of required labour (73. per cent), rigid security requirement (45.00 per cent), non-availability of market related information (28.33 per cent), faulty weighment (13.33 per cent), non-availability of information on improved technologies (8.30 per cent), inaccurate weighing instruments (6.66 per cent) were the other problems expressed by the sample farmers)

Conventional method

Bio-Physical problems

From the Table 4.14, it was revealed that, high incidence of pests and disease was the major Bio-physical problem expressed by the (95.00 per cent) sample farmers. Lack of storage facilities (88.33 per cent), lower yield per hectare (70.00 per cent), non-availability of water for irrigation (51.66 per cent), and non-availability of suitable high yielding varieties (31.66 per cent) were the other problems expressed by the sample farmers.

Socio-economic problems

Results obtained from the Table 4.14, revealed that 98.66 per cent of the farmers expressed fluctuations in the prices of commodity as the major socio-economic problem. Costly plant protection chemicals (78.33 per cent), absence of higher price in the local markets (68.33 per cent), more burden of repayment (53.33 per cent), delay in getting credit (43.33 per cent), high commission charges (38.33 per cent), high rate of interest (21.66 per cent), insurance coverage problem (20.00 per cent), non-availability of credit (13.33 per cent) were the other problems expressed by the sample farmers.

Other problems

Results revealed that non-availability of required labour (75.00 per cent) was the major problem faced by the sample farmers. Non-availability of information on improved technologies (51.66 per cent) non-availability of market related information (40.00 per cent), rigid security requirement (35.00 per cent), faulty weighment (16.66 per cent), inaccurate weighing instruments were the other problems expressed by the sample farmers.

Policy implications

Based on findings of the study following policy implications were drawn.

1. The yield and returns in transplanted method were higher besides helping the crop to escape from pod borer attack due to early sowing. Hence, there is a need to popularize transplanting system among the farmers with the help of SAU's, KVK's and NGO's.
2. In the case of conventional method, there is a need of optimum usage of all the inputs used while in transplanted method, it is restricted to plant protection chemicals (PPC's) and labour.
3. There is a need to strengthen extension service system as it is playing an important role in adoption of transplanted system by training programmes, demonstrations and educational trips to farmers.
4. There is a need for creation of storage and processing units by government, so that farmers can be protected from price fluctuations besides getting more returns.
5. Many of the farmers expressed absence of higher price for their produce. Hence, there is a need to strengthen Karnataka State Tur Board, acting as a market intermediary for creating competition in the market.

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Appendix I: Model price of pigeonpea in Gulbarga and Bidar markets

Months	Gulbarga	Bidar
January	4450	4200
February	4150	3800
March	3857	4000
April	4289	4500
May	4157	4200
June	3801	4900
July	3861	3200
August	3434	3351
September	3425	3400
October	3351	2500
November	3109	2900
December	3050	2800
Total average	**3743.66**	**3604.25**
Model price from June 2010 – June 2011	**3731**	**3665**

Appendix II : Interview schedule

UNIVERSITY OF AGRICULTURAL SCIENCES – DHARWAD - 05
DEPARTMENT OF AGRICULTURAL ECONOMICS

Research Title : Comparative economics of pigeonpea production under transplanted and conventional methods in selected districts of Northern Karnataka"

Schedule no

I. GENERAL INFORMATION:

1. Name of the respondent:

   Village:

   Taluk :

   District:

   b. Occupation: Primary:

   Secondary: 1.

   2.

2 .Family Particulars:

Sl. No	Name	Sex	Age	Education	Whether engaged in farming
1.					
2.					
3.					
4.					
5.					
6.					

3. Land holding (hectares):

(a)

Sl. No	Types of land	Owned	Leased in	Leased out	Total
1.	Dry				
2.	Irrigated				

(b) Source of Irrigation

Sl. No.	Source	Area irrigated(acre)
1.	Open well	
2.	Bore well	
3.	Canal	
4.	Tank	
5.	Others if any	

4. Cropping Pattern (2009-2010)

Season	Crop	Area	Dry / Irrigation
Kharif	1.		
	2.		
	3.		
	4.		
	5.		
Rabi	1.		
	2.		
	3.		
	4.		
	5.		
Summer	1.		
	2.		
	3.		
	4.		
	5.		

5 Asset Position:

Types of assets	Nos	Year of purchase/ Constuction	Purchase/ Construction Value(Rs)	Junk value	Expected life span
Building					
Bullock cart					
Livestock					
Tractor					
Implements					
1. Pumpset					
2. Irrigation equipments					
3. Others					
(i)					
(ii)					
(iii)					

II: Cost of cultivation **Type : Transplanted /conventional**

Crop: Area (hectares):

Variety: HYV/Local Season: *Kharif /Rabi/Summer*

a) Labour charges:

Cost of hiring labour

1. Men (Rs /day) :
2. Women (Rs /day) :
3. Bullock pair (B pair /day):
4. Machine labour (Rs/hr)

Particulars	No of times	Family labour				Hired labour			
		M	W	BP	ML	M	W	BP	ML
Ploughing									
Harrowing									
Transportation of FYM									
Spreading of FYM									
Transportation of soil.									
Seedling preparation									
Watering of seedlings									
Sowing/Transplanting									
Fertilizer /organic manure application									
Clipping.									
Hand weeding									
Inter cultivation									
Spraying PPC/Biopesticides									
Irrigation									
Harvesting									
Transportation									
Others									

Note: M = Men, W = Women, BP = Bullock pairs, ML = Machine labour

b) Input cost

Particulars	Quantity (kgs)	Price /unit	Total cost(Rs)
Seeds			
Seed treatment chemicals			
Fertilizers/Biofertilizers /FYM			
1.			
2.			
3.			
Polythene bags			
Pesticides /Biopestcides			
1.			
2.			
3.			
4.			
Irrigation charges			
Land revenue			
Rental value of land			
Others (specify)			

c) Marketing cost

1. Transportation cost :
2. Commission paid :
3. Any other charges (specify) :

III. Details on returns **Type : Transplanted /Conventional**

1. Crop :
2. Area sown :
3. Yield/acre :
4. Price (Rs/qtl) :

   Gross returns:

IV. Problems faced by the cultivars of pigeon pea

Sl. No.	Problems	Yes	No	Remarks
A	**Production related problems**			
1	Non availability of short duration HYV's			
2	Non availability of water for irrigation			
3	Higher incidence of pest and disease			
4	Costly plant protection chemicals.			
5	Non-availability of required labours during peak season			
6.	Non availability of information on improved technologies.			
7.	Lower yield pre hectare			
8.	Damage of pods due to bending of branches			
9.	High labour requirement			
B	**Marketing problems**			
1	Lack of storage facilities			
2	Non availability of market related information			
3	Fluctuation in the prices of commodities			
4	High commission charges			
5	Faulty weighment			
6	In accurate weighing instruments			

Sl. No.	Problems	Yes	No	Remarks
7	Absence of premium price in the local market			
8	Others (If any)			
	Financial problems			
1	Non-availability of credit			
2	Delay in getting credit			
3	High rate of interest			
4	More burden of repayment			
5	Rigid security requirement			
6	Insurance coverage problems			

COMPARATIVE ECONOMICS OF PIGEONPEA PRODUCTION UNDER TRANSPLANTED AND CONVENTIONAL METHODS IN SELECTED DISTRICTS OF NORTHERN KARNATAKA

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ABSTRACT

Indian rural economy is basically considered to be a crop economy. Transplanted method is one of the recent developments contributing to the higher yields in pigeon pea cultivating areas of Northern Karnataka. The per hectare average yield of pigeonpea on transplanted farm (26.25 qtl/ha) was higher than that of conventional system of pigeonpea growers (15.25 qtl/ha).

The cultivation of pigeon pea in transplanted method was found to be more profitable compared to conventional method. Total cost of cultivation in transplanted method and conventional method were Rs. 39,382.28 per hectare and Rs. 30,819.53 per hectare respectively. Net returns were found to be higher in the case of Transplanted system (Rs. 54,103.25/ha) than in conventional method (Rs. 25,562.78/ha). Resources were optimally used in transplanted system, whereas in the case of conventional system, resources were not used optimally. The coefficient of multiple determination (R^2) was 0.72 and 0.69 for conventional and transplanted system of pigeonpea growers, respectively.

Age, education, income level, area under pigeon pea, irrigation availability, extension contact and family labour availability were the factors influencing the adoption of transplanted system of pigeon pea. Among these, education of the farmer and his extension contact were found to be the major factors influencing the adoption of transplanted method of pigeonpea cultivation.

Problems faced by the growers of pigeon pea were studied under bio-physical, socio-economic and other. Higher incidence of pests and diseases was a major bio-physical problem while fluctuation in the prices of commodity and non-availability of required labour were the worth noting socio-economic and other problems, respectively.